LIPPINCOTT'S AGRICULTURAL SCIENCE SERIES

★ SHEEP SCIENCE ★

by

WILLIAM GARFIELD KAMMLADE
PROFESSOR OF SHEEP HUSBANDRY
UNIVERSITY OF ILLINOIS

Edited by
R. W. GREGORY

★

J. B. LIPPINCOTT COMPANY
CHICAGO PHILADELPHIA NEW YORK

4.5212.8

PRINTED IN THE UNITED STATES OF AMERICA

Preface

Wars, national and international policies, changes in demand, competition for the use of land, labor and capital, changes in population, and many other matters affect industries. Sheep raising has its unique and peculiar features, but it is not less subject to change because of these various factors than other industries. Change does not always mean progress but there is no progress without change. Some aspects of sheep raising have changed much in the past few decades and further changes are certain. There has been no fully comparable period in history, and it is impossible to forecast what an always uncharted future holds. Knowledge and experience enable those engaged in any occupation to react most intelligently and wisely to opportunities and to varying conditions.

This book is intended primarily as a text for use in colleges. The aim has been to present a comprehensive review and treatment of the great volume of published material relating to sheep and wool. Much sorting, classifying, and analyzing have been necessary, for some of the material reviewed is conflicting, some indecisive, some is based on limited experience in a locality, some on sound research and wide application. The endeavor has been to view the industry on a national basis and avoid localization.

Little attention has been given to detailed aspects of sheep raising in foreign countries. Certain phases such as elementary judging and breed histories have been accorded little space, for there are already several books dealing with them and mere restatement would be of little consequence. General principles have been emphasized as contributing more to the intellectual development of students than would be secured from the presentation of detailed rules for the performance of a multitude of tasks which are best learned under conditions of apprenticeships.

This book does not contain everything students should know.

It is assumed instructors will provide additional information and assign supplementary reading and problems. The subject matter presentation may not be the best, but it has been followed in the author's classes and seems logical.

The basis of this text is the reports of the work of many people. I acknowledge the great help obtained from consulting these reports and using material from them. Sincere appreciation for the gracious response to requests for illustrations is also expressed.

Contents

CHAPTER		PAGE
1.	The Sheep Industry	3
2.	The Characteristics of Sheep	15
3.	The Life of Sheep	26
4.	Types and Breeds	39
5.	The Southdown	47
6.	The Shropshire	54
7.	The Hampshire	62
8.	The Suffolk	71
9.	The Oxford	76
10.	The Dorset	81
11.	The Cheviot	86
12.	The Corriedale	90
13.	The Columbia	95
14.	The Leicester	99
15.	The Lincoln	103
16.	The Cotswold	107
17.	The Romney	110
18.	The Merinos	115
19.	The Rambouillet	124
20.	New and Minor Breeds	134
21.	The Karakul	139
22.	Judging, Selecting, and Classifying Sheep	145
23.	The Organization and Operation of a Sheep Enterprise	158

CHAPTER PAGE
24. Equipment 188
25. Sheep Breeding 201
26. Breeding Season Practices 231
27. Developing a Productive Flock 235
28. The Nutrition of Sheep 243
29. Feeds 258
30. Feeding and Management Practices 288
31. Lamb Feeding 324
32. The Character of the Business—Economic Considerations 333
33. Selection and Purchase of Feeder Lambs 347
34. Feed-lot Management and Rations for Fattening Lambs 361
35. Wool 388
36. The Meaning of Wool Terms 398
37. The Wool Fiber 407
38. The Value of Wool 417
39. Wool Marketing and Manufacturing 431
40. Diseases and Parasites 452
41. The Western Range Area 492
42. Managing Sheep on the Range 505

Index 529

Sheep Science

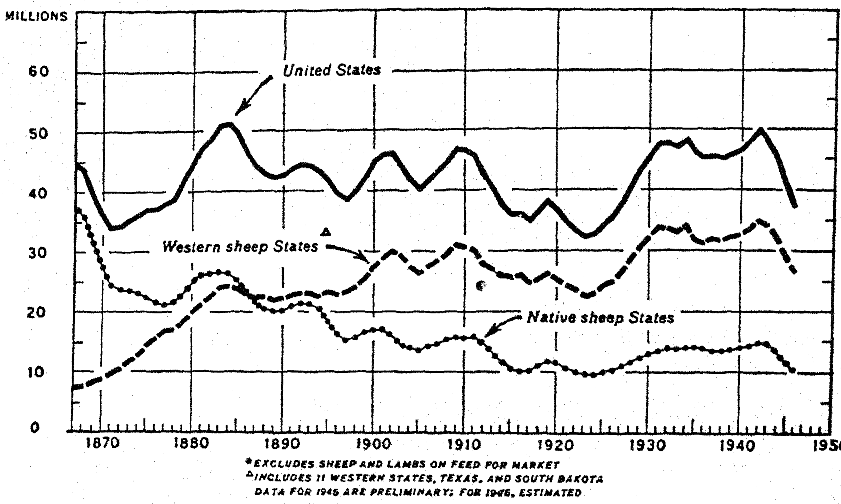
CHAPTER 1

The Sheep Industry

The sheep industry is world-wide, but it is of greater importance in some countries than in others. It is of no particular consequence from an international viewpoint in most tropical areas. In temperate zones, however, sheep raising has been and is an important industry. Although wool is not consumed in such large quantities as cotton, it has been of more importance in making it possible for man to withstand the rigors of the climate during winters in those countries now dominant in world affairs. These areas now have the largest numbers of sheep, and their products are important items of commerce and trade.

The reports of numbers of sheep in many countries are not accurate, and there are drastic changes from time to time. But these data do show the most prominent sheep-producing areas. It is not surprising to find great differences in numbers in the different countries because of the differences in land area, topography, type of agricultural enterprises, and density of human population. Sheep raising has been a frontier industry and now, with few exceptions, is most extensive in those countries that have vast land areas that are sparsely settled. These conditions are found more commonly at present in the Southern Hemisphere, and it is there that most of the world's sheep are located. But there are areas within countries of the Northern Hemisphere with many great flocks and numerous small ones.

Effect of war. Many factors affect the sheep industry, and its history is characterized by periods of abounding prosperity followed by periods of severe depression. This is likewise the history of many other businesses; the cycles of the sheep industry have been both more and less severe than those of some other occupations. War has always played a prominent part in stimulating the sheep business, and the cessation of conflict has usually been followed by a decline in demand for wool. The two latest wars have been no



Courtesy U. S. Department of Agriculture

This graph shows the number of stock sheep and lambs on farms in the United States from January 1, 1867–1946. There has been a decrease in sheep since 1942. The number in 1946 is about the same as twenty years earlier.

exceptions. There has been a great demand for wool, but some outlets for wool have been curtailed because labor was scarce where wool was available, and other outlets were closed by blockades. Stocks of wool accumulate in producing countries during war, and these accumulations are difficult to dispose of without bringing about large price recessions. These difficulties result in a great variety of remedial governmental policies by the various countries, but they are generally only partially successful. A rather ineffective demand accompanied by a great need develops in countries deprived of wool during the war period, but this need cannot be met promptly because of the poverty which is an effective destroyer of demand. Need without ability to purchase does not create profitable markets. This condition now confronts many nations of Europe and Asia. Fortunately, wool is relatively imperishable, and its usefulness does not depend upon immediate use. But there are few exceptions to the statement that the termination of wars has brought hardships to the sheep producers.

Sources of income. In the sparsely populated regions of most countries, sheep have met with severe competition from cattle.

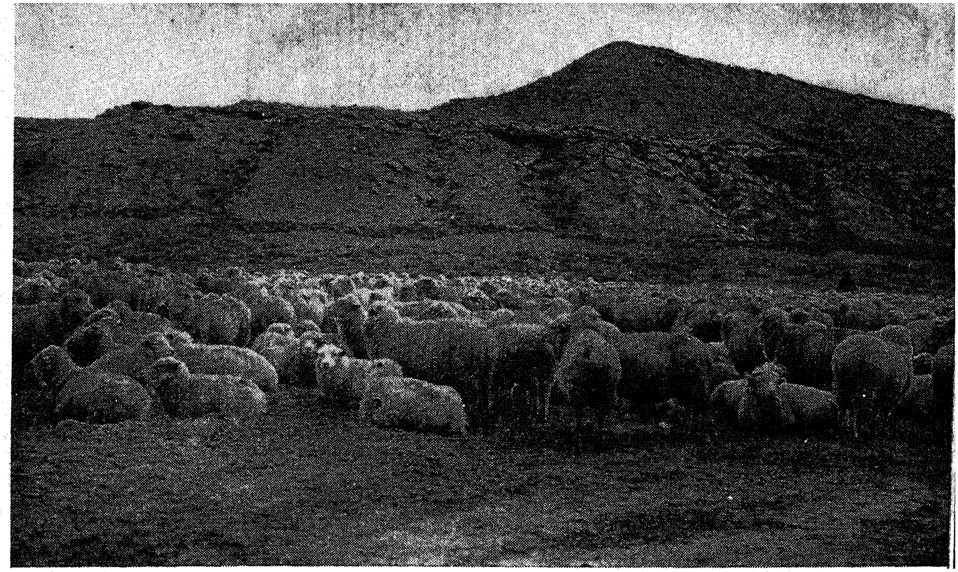
Later, both the sheep and cattle raisers in such sections were confronted by the farmers who, because of better transportation facilities, invaded such regions to produce other farm products on a more intensive basis. Thus, another form of competition had to be met, and this led to many adjustments, such as changes in the types of sheep and greater emphasis on meat production. In this country at the present time, the main source of income is from lamb, which accounts for from one-half to three-fourths or more of the total annual income from ewes. Wool production is, however, important, though it is no longer true that the returns from wool will cover the items of cost and leave the returns from lamb as profit. Indeed, it is doubtful if this ever was true to any great extent. In many cases at present, it takes the returns from the sale of lambs to cover the items of expense, and if the returns from wool were net profit the industry would be generally prosperous. Sheep raising has to meet the competition of other enterprises, and it must add significantly to the net income of farmers or be abandoned. This addition is being secured in many instances, but there are producers who are continually on the border line between profit and loss. The frontier aspects of the business have passed, costs have risen, and good management in all phases is as important as in any other enterprise. The sheep business is now one of fixed costs that cannot be avoided. In some countries milk is a source of income, but dairying with sheep has not developed in the United States.

Wool consumption. During peace times in this country, the per capita consumption of wool is roughly about four pounds yearly. During the war the amount rose to about eight pounds. Many people in the warmer parts of the country use very little wool. Wool has become a luxury as well as a utility fiber. As a luxury and protective fiber, however, it must meet the competition of a very aggressive new industry built on manufactured fibers. None of these fibers have all the attributes of wool, but the sheep raisers must not be unaware of the possibilities of this competition. The unique features of wool as a textile material must be continuously impressed upon consumers by the same means that competitors use to put forth the merits of other products. This means that a larger percentage of the income of growers will probably have to be used for advertising and promotional purposes. This is a part of modern business that those who raise sheep must not overlook. Individual producers cannot accomplish much in this field, but

through cooperative organizations some benefits can be obtained.

Lamb consumption. Lamb consumption amounts to about seven pounds per capita annually in the United States. This is about 10 per cent that of beef and about the same percentage of the consumption of pork. Many people do not eat lamb. The large cities east of the Ohio River, on the Pacific coast, and some in the Central States are the chief consuming centers. Various groups, chiefly producers and packers, actively promote an increase in lamb consumption from time to time by stressing the nutritive value of this meat. Prejudices are difficult to overcome, and this is especially so when there are well-established preferences for other products which must be replaced by the new article in the diet. Increased lamb consumption is possible in two ways. These are through establishing lamb as a part of the diet of more people and through the natural increase due to increased population. The former means some replacement of other articles through the development of a liking for lamb. This is not an impossibility, but is a thoroughly competitive undertaking. An increased demand for all foods arises naturally as the number of people increases. There is not, however, any possibility of an increased consumption of lamb in this country except through an increased production or through importation. The latter would be of no benefit to domestic producers. All of the lamb now produced in this country is consumed here, and an increased consumption must be preceded by an increased production. For the most part, lamb consumers are found in the higher income groups among the population.

Land use. Great areas of grasslands have always characterized the regions of large sheep production. As these areas have been appropriated for other types of agriculture and many of the sections cultivated without regard to the suitability of the lands for permanent use in other than grassland types of agriculture, sheep raising has declined. In many areas where there have been enormous losses of soil resources due to a lack of consideration of proper land use, sheep raising is advocated as a means of developing agriculture anew. Sheep will always be especially suitable for a grassland type of farming. Hence, where pastures are small and farming intensive, small flocks will be found. In England, for example, when grassland development was urged, sheep increased. With emphasis on cultivated crops during the war period, sheep numbers declined. Only as pastures are emphasized in farming, will there be important



Many arid regions such as this one provide sufficient feed for robust types of sheep.

numbers of sheep. Certain types of soil conservation and development practices, therefore, may be accompanied by the establishment of more flocks in a region. Because sheep can graze forage closely, they have been credited with causing the soil to become subject to erosion. This is true in some instances, but it is undoubtedly true that far more erosion has been caused by the production of cultivated crops for some other types of animals than has been caused through grazing by sheep. This statement is based on studies which show that the disturbances of the soil through cultivation is the most effective way to make it subject to erosion. Judicious grazing by sheep or other animals is of course advisable regardless of these contentions. Pasture development and improvement in many sections is not only a requisite for economical sheep production but for intelligent land use also.

Types of sheep raising. In most countries the pioneer phases of the industry have passed, and extensive new lands are not available for occupancy. Thus conditions indicate that the industry will become stabilized or further develop along three main lines or types of production.

First, in arid and semi-arid regions where feed is not sufficient for satisfactory lamb production, the emphasis will be on the maintenance of flocks for the production of the finer grades of wool, with lamb raising as a secondary consideration. A robust, hardy

Courtesy Grazing Service

Large flocks of crossbred types predominate in areas where vegetation is ample for market-lamb production.

type of sheep is required for such areas, and practically all lambs raised will be sold for feeding in other places. When some parts of such regions are developed by means of irrigation, the sheep raisers are handicapped because the lands may then be used for some other purposes. If this is not the case, there is more emphasis placed on meat and less on wool. Costs of operation must be low where wool is emphasized, and it is only under extensive range conditions that such conditions are found. This type of production is apt to decrease in most other countries as well as in the United States.

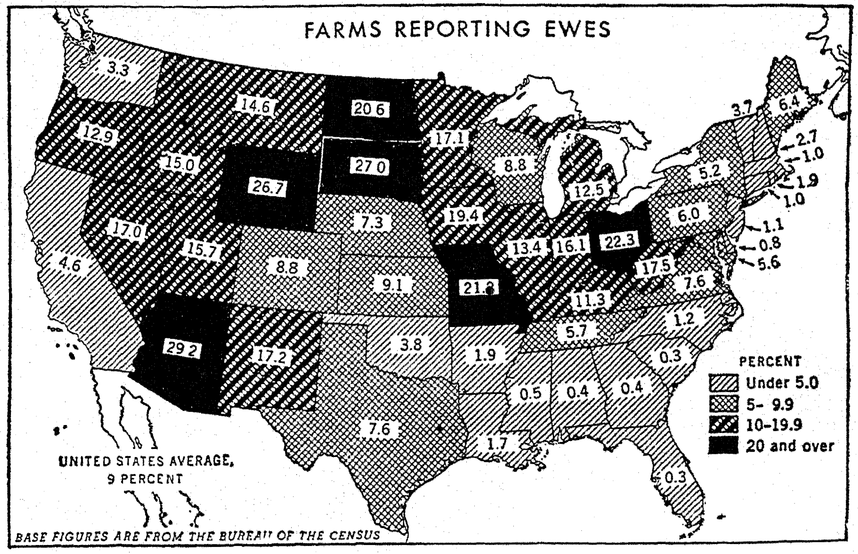
A second type of sheep raising in semi-arid and sub-humid areas where intensive agriculture is not possible places more emphasis on lamb raising, but there is also considerable emphasis on wool. This type of industry is found in the better range areas where the rainfall is deficient for farming or where the topography is such as to prohibit farming, but where there is an abundance of nutritious vegetation even if it does not cover the ground completely. Because of higher operating costs, than in the case of the first type, crossbred types of sheep predominate. These types produce coarser-fibered wool than most of the flocks kept primarily for wool production, and they also yield lambs of more desirable shape and meat quality. Many efforts have been and are being made to develop sheep that will produce satisfactorily under these range conditions. In this type of industry many fat lambs are raised, but there

are some that are sold for further feeding. Seasonal conditions have great effects upon the lambs.

For the most part this type of sheep raising is carried on in large flocks. A flock or band may contain from 1,000 to 1,500 ewes under the care of a herder who keeps them on a large area of unenclosed land. These lands may comprise deserts, plains, foothills, and mountains, which are used at different seasons of the year in such a way as to afford reasonably good feed throughout the year. Some ranges are now supplemented with such feeds as corn, oats, barley, protein concentrates, and hay. These feeds are provided to avoid severe death losses due to lack of sufficient feed during unfavorable seasons or during the heavy storms of winter. Some of these feeds, especially corn and protein, are shipped in, but much hay and grain are raised in the irrigated sections of the range country. Hay, especially alfalfa, is of more importance and is used more extensively than any other feed for supplementing winter range.

Most of the range flocks in this country are kept on unfenced areas, but in parts of the Southwest many of the ranges are fenced. Since fencing is impractical in rough country, fences are not found in the mountainous regions. Scarcity and cost of labor were the two chief reasons for the construction of fences. Fenced ranges or paddocks have been used in Australia and New Zealand more extensively than in this country. In areas where feasible it is likely that this type of range management will develop further, although it does not do away entirely with the need of caretakers. Fences are found only on privately owned lands, and since much of the range land in the West is publicly owned and likely to continue so, fences will not be built. It is claimed that fenced ranges will carry many more sheep—in some cases double the number—than when sheep are herded on the same area. Fences afford some protection against some predatory animals, and larger lamb crops are raised. Less forage is destroyed by heavy trampling when the sheep are allowed to scatter out; this they cannot do so satisfactorily under the herding system, although a "good spread" is one of the important points in good herding.

The third type of enterprise centers in the humid farming areas and stresses lamb production, with wool of secondary importance. Some lands in such areas are less subject to erosion when kept in pastures than when cultivated. Under such conditions the sheep flock must compete with other grazing animals, such as beef



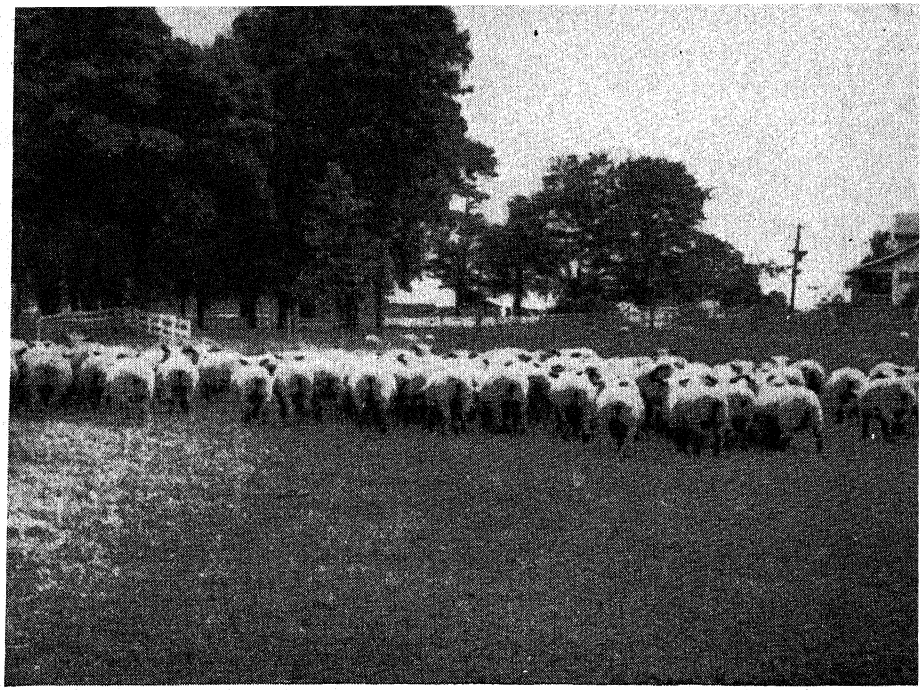
Courtesy U. S. Department of Agriculture

This map shows the percentage of all farms reporting ewes, April 1, 1940. The states in which less than 5 per cent of the farms were reported as having ewes are states that had small numbers of sheep. Texas had 7,224,000 more ewes than any other state, but only 7.6 per cent of all farms in that state were reported as having ewes. In Arizona 29.2 per cent of the farms were reported as having ewes, but the state had only about 8 per cent as many ewes as Texas.

and dairy cattle, and animals of pronounced meat type compose most of the flocks. Most breeds of sheep meeting this requirement have been imported from England. There are farms in all states that maintain flocks along with a number of other enterprises. Many farms do not maintain sheep.

Farm flocks often contain less than 25 sheep and seldom more than 400 or 500. The smaller flocks are generally farm scavengers with respect to forages and are given the task of keeping the farmsteads and harvested fields free of weeds. Such flocks are not under the care of special caretakers and often are neglected by farm workers, who find other duties more imperative. Since these flocks represent such a minor investment compared with other enterprises on the farm, it is not surprising they are among the first things to be neglected.

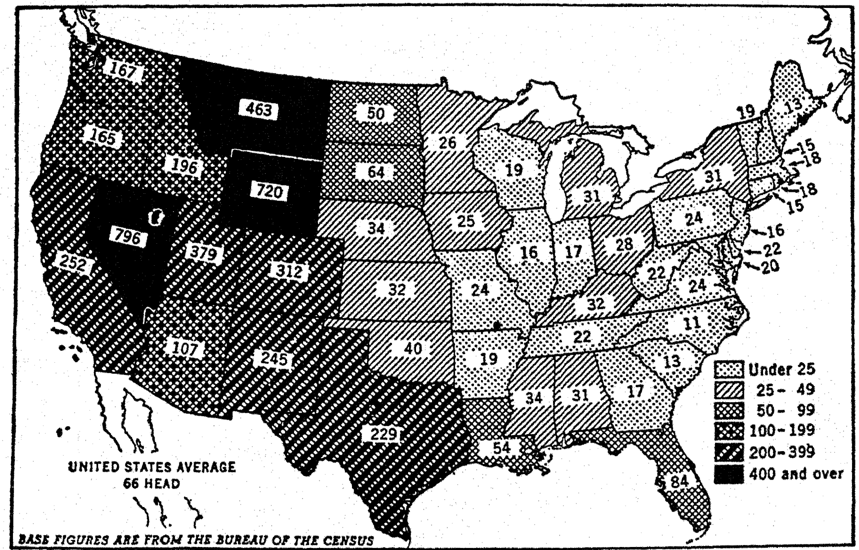
Farm flocks of such size as to be of some consequence with


Courtesy L. T. Dwyer, Franklin, Indiana

Flocks of mutton-type sheep are sources of profit in farming sections.

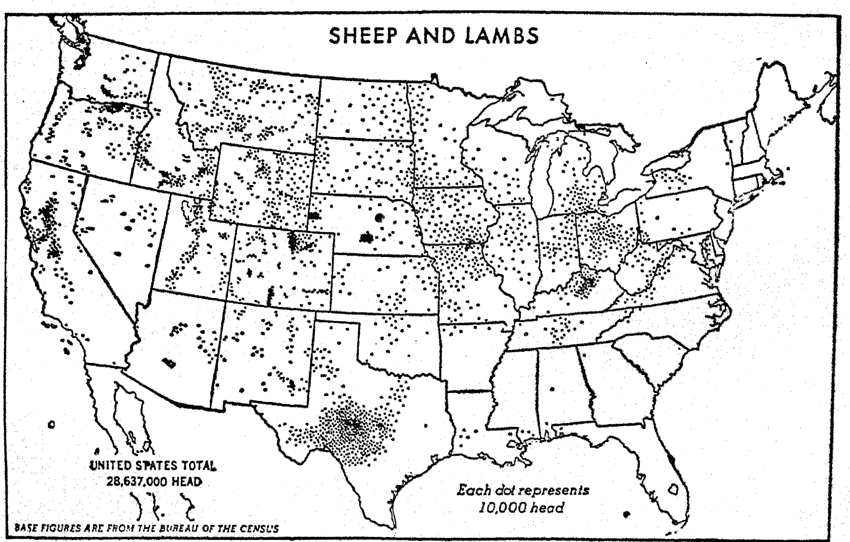
respect to investment and other matters are not subject to neglect, and special equipment and care are provided. Some cultivated pastures may be grown, and these may be carefully grazed by means of cross fencing or other provisions. Some very intensive enterprises are carried on by means of succession of pastures. Purebred flocks as well as commercial enterprises characterize the farm or humid-area type of sheep raising. The producer of purebreds has as his principal object the sale of breeding stock to those engaged in commercial phases of sheep raising, and he needs knowledge of many things about which the commercial producer is not concerned.

Lamb feeding. In addition to these sheep-raising activities which are based on the maintenance of breeding flocks, there is an extensive feeding industry. This is based on the purchase of lambs from the areas where the first two types of production are carried on, shipping them to areas where there are surplus feeds for further development and fattening. This feeding industry centers in the irrigated sections of the West and in the Corn Belt states. Feeding is a specialized phase which is most widely carried on during the

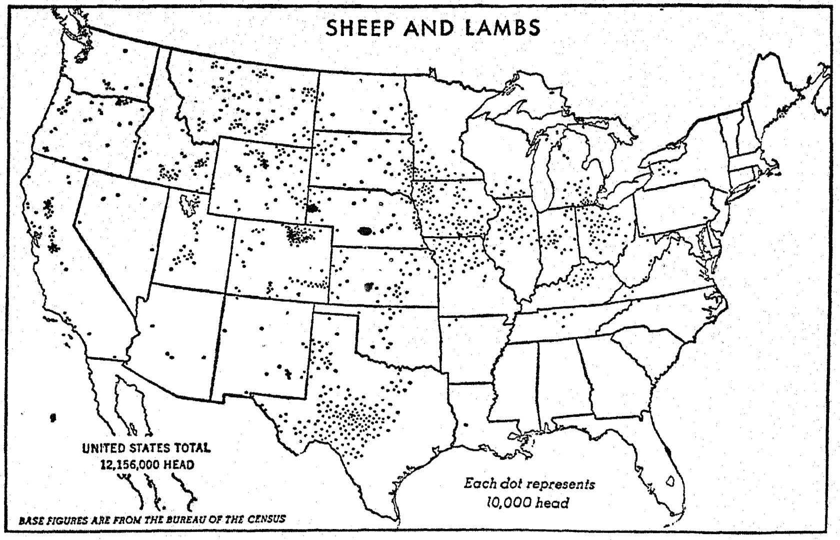


Maps courtesy U. S. Department of Agriculture

This map shows the average number of ewes per farm reporting ewes, April 1, 1940. At this time the average number of ewes on farms was less than a hundred in all the states except Texas and the western states.



The number of sheep and lambs reported sold in 1939 was about 70 per cent of the number reported on farms, April 1, 1940. The 3 states that led in the number of sheep and lambs sold were: Texas, with 4,654,000; Wyoming, with 2,034,000; and Montana, with 1,987,000.



Courtesy U. S. Department of Agriculture

The number of sheep and lambs bought by farmers in 1939 was 12,156,000, more than 2 million less than half as many as those sold. Most of the purchases were made by farmers in the irrigated areas of the West, especially in Scotts Bluff and Dawson Counties, on the North and South Platte Rivers of Nebraska, and in the South Platte and Arkansas valleys of Colorado. Large numbers of sheep were also bought by farmers from one another in the Edwards Plateau of Texas and, on a small scale, throughout the Corn Belt as well.

fall and winter months. Various methods are employed by feeders, but all have for their purpose increasing the weight and amount of fat so the lambs or sheep will bring a higher price when ready for sale than when they were bought. Many farmers use sheep purchased in this way to clean up the farm and to provide a market for much unmarketable feed, although large quantities of feed that have high market values are also used. There are many special aspects of this business that receive detailed attention later in this book.

Financing sheep raising. In the farm sheep-raising sections no special facilities are provided for financing sheep raising as the amount invested in the flock is generally small. Lamb feeders have available various sources of credit, most of which require a mortgage on the lambs and, in some cases, on the feed also. This is generally a short-term loan, rarely exceeding six months and often

not extending for more than three months. Agricultural credit facilities sponsored under various acts of the Federal government are available to feeders. Loans may also be secured from private agencies.

Credit for extensive operations such as the range outfits carry on is a constant need because few men engaged in this business, as is the case in most other businesses, have sufficient capital to operate without additional finances. Suitable credit facilities for sheep raisers constitute a part of the general problem of livestock financing. While sheep loans have often not been looked upon as favorably as cattle loans, the former usually liquidate themselves more quickly because lambs mature more rapidly than calves, and there is also the return from wool. However, sheep are more subject to loss because of extremely severe weather and depredations by wild animals, and sheep are not so readily identifiable as cattle by such means as branding. Loans are usually limited to two-thirds, seldom more than three-fourths, of the total value of the flock.

CHAPTER 2

The Characteristics of Sheep

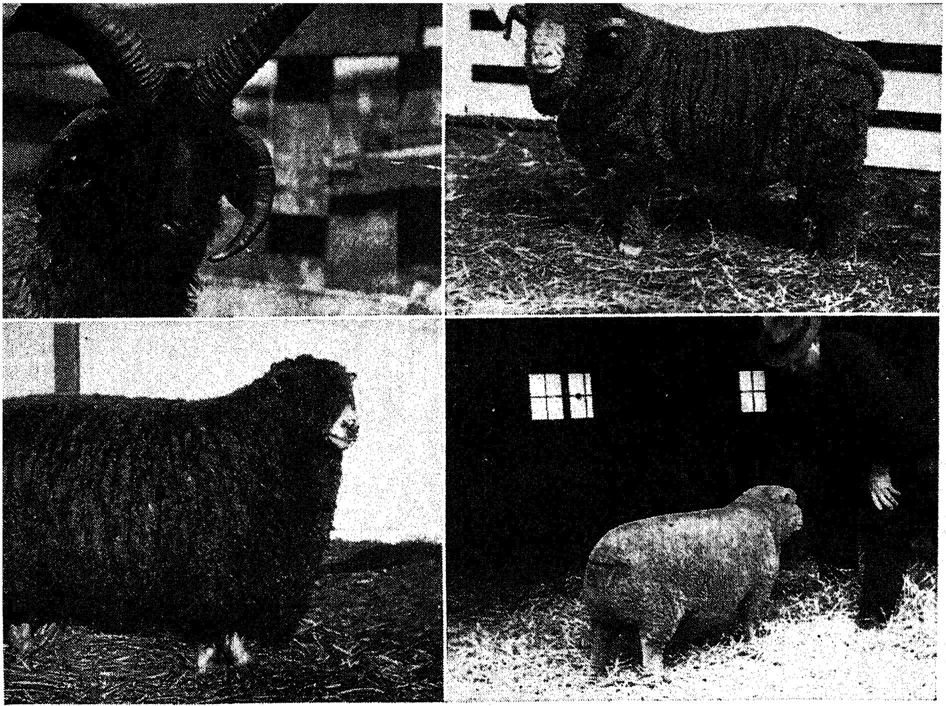
Ancestors of present-day domesticated sheep were probably related to the Urial, Argali, and Mouflon types of wild sheep found in some Asiatic and European countries at the present time. Primitive breeds will cross with the Mouflon, which shows that a close zoological relationship exists. Lydekker [1] shows the position of the domesticated sheep among the vertebrates of the animal kingdom in the following tabulation:

Subkingdom *Vertebrata*—Vertebrates, or back-boned animals
  Class *Mammalia*—Mammals, those which suckle young
    Order *Ungulata*—Hoofed mammals
      Suborder *Artiodactyla*—Even-toed ungulates
        Section *Pecora*—Typical ruminants
          Family *Bovidae*—Hollow-horned ruminants
            Subfamily *Caprinae*—Sheep and goats
              Genus *Ovis*—Sheep
                Species *Ovis Aries*—Domesticated sheep

On the basis of studies it seems probable too that certain sheep found today are not greatly different from some which lived some thousands of years ago. There are many types and breeds common to many sections of the world which bear close resemblance to descriptions of what studies reveal about prehistoric sheep. Many of the characteristics which are said to have distinguished the ancestors of sheep from existing species are of no great significance, and there seems to be no evidence that some earlier species of great consequence no longer exist.

External differences. There are great variations in the external characters of sheep, manifested in the number and form of horns, in the shape and size of ears, in an arching of the nasal bones in some types, in the length of the tail, and in the development of great masses of fat at the base of the tail. These fat deposits are

[1] R. LYDEKKER. The Sheep and Its Cousins. E. P. Dutton and Co. 1913.



Courtesy University of Illinois

At the present time great variations in head features, wool, form, and size are found in sheep: top left, the multiple-horned, coarse-wool sheep; top right, the American Merino fine-wool ram; bottom left, the Lincoln, a large, long, coarse-wool type; bottom right, the Southdown, a small medium-wool type.

at times so excessive as to be artificially supported through appliances made by the caretakers. There are extreme variations too in the color of the face and other parts not covered with wool. Great variations exist in the quality and color of the fleece.

These variations have provided the basis for efforts to improve sheep. According to modern conceptions of what constitutes an approved type of mutton sheep, the unimproved animals are poorly shaped. Their necks, legs, and bodies are too long, narrow, and too thinly fleshed. Plumpness and rotundity of form have been emphasized so that the best specimens of the modern breeds retain slight resemblance to earlier types. Yet despite this, there are many sheep which have some features that remind one of the ancestral types.

Variations in wool. Even in modern breeds wool is far from showing complete uniformity. Variations in early types were pro-

nounced with respect to color, length, fineness, and other characteristics. Such differences exist today also, but in such breeds as the Merino, where wool quality has been emphasized by breeders, much of this variation has been eliminated in the best specimens. Sheep do not, however, have wool of absolute uniformity, for there are variations which seem to be associated with different parts of the body. The wool on the shoulders is finer than that which grows on the thighs and about the tail. Wool that grows on folds in the skin is likely to be considerably coarser than that which grows between the folds.

Breeders in Australia have been leaders in the improvement of wool. Some efforts that were founded on misconceptions of what constituted improvement in wool resulted in the development of types of sheep that now are not looked upon with favor, although they once were considered to be the culmination of the breeders' art. Most of these misconceptions regarding wool were based on excessive weight of fleece, which was striven for through an abnormal amount of grease or yolk rather than through the production of increased amounts of wool fibers with suitable fineness and length. Changes in manufacturing processes have probably reduced the need for the highest development of all desirable features of wool, and the demand for meat has resulted in more emphasis upon mutton qualities in sheep in many areas, with a consequent lessening of interest in wool. But wool does remain a product of importance, and efforts to further improve it are constantly made. Many efforts are directed toward securing in one animal a highly developed combination of both meat and wool characters.

Sheep differ from other Bovidae. Sheep belong to the family of hollow-horned ruminants, which includes such classes of animals as cattle, goats, chamois, antelopes, and others. Practically, sheep form a group which is impossible of exact definition as they pass imperceptibly into the goats. Wool does not distinguish sheep from goats, as there are sheep which do not produce wool; yet the two are distinct, for they do not crossbreed—there have been many efforts to bring about such crosses. Sheep and goats, however, have similar breeding habits, and the period of gestation is not greatly different; in fact, there are many instances when it is the same for both species. Rams do not have a tuft of beard hairs on the chin like male goats show. Mohair of Angora goats has some of the same characteristics as wool from the coarse-wool types of sheep. The

horns of sheep may differ generally from those of goats, but here, too, there are cases of great similarity. In sheep the horns are generally angular rather than rounded, and across the surface there are fine transverse wrinkles. In most cases the horns grow slightly backward and downward, then curve forward in an outward spiral. In some of the primitive breeds the horns may be straight, and they may be increased from the normal two to four or even eight. Rams and ewes are horned in some breeds, rams only in others, and in others neither rams nor ewes have horns.

Compared with cattle, sheep show many similarities; yet the two have striking differences. Sheep are much smaller than cattle. Sheep of the smallest breeds weigh 80 to 125 pounds. Exceptional specimens of the large breeds weigh up to 350 or 400 pounds. The hair of cattle is much unlike the wool of sheep, but there are many sheep that have a hairy outer coat and a very fine undercoat. It is likely that wool has been developed through the elimination of the outer coat and the stimulation of the finer undercoat. It is not uncommon to find in newborn lambs two distinct coats. In some cases part of the outer coat may be retained and reduce the value of the wool.

Sheep carry their heads higher than cattle, and the upper part of the head is much more developed in breadth than is the muzzle. The ox has a broad, naked muzzle. The sheep's muzzle is much narrower and thinner and is divided by a vertical cleft. This gives the external mouth parts of the sheep great flexibility and permits it to eat certain fine parts of plants or to eat species of plants which are growing in very close proximity to other species. This feature of sheep also enables them to graze slightly closer to the ground than cattle are able to do. These things have a bearing on the type of management most suitable under some conditions.

The majority of sheep have glands which open on the surface of the skin below the eyes. These are known as suborbital glands, or crumen. The secretion is sometimes excessive and gives an impression of coming from the eyes. The ducts are located in a depression of the skull just beneath the inner corners of the eyes. The secretion from these glands is of a fatty or sebaceous nature.

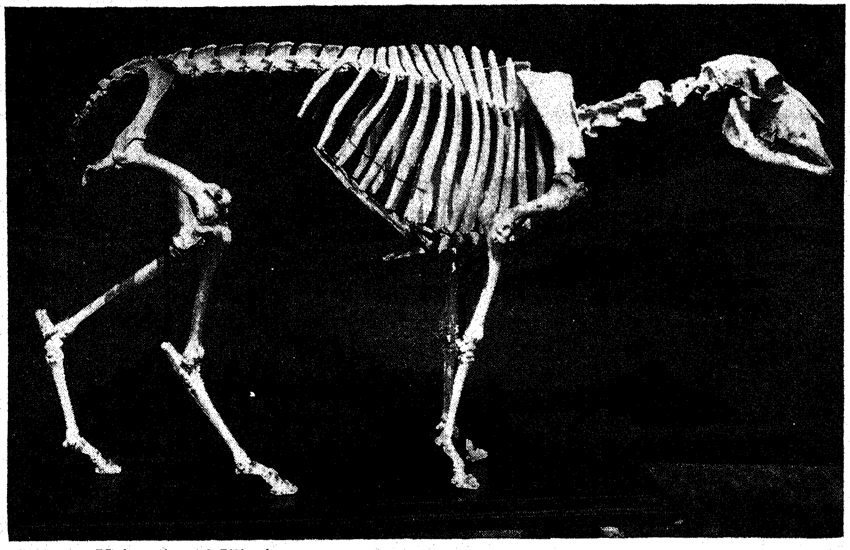
Between the two toes is a deep glandular pouch with a small external opening at the front part of the foot. This opening is readily seen and is found on both the front and hind feet. The secretion from these interdigital glands is oily and has a peculiar

odor, although it is not very pronounced. It has been said that these ducts may become plugged with mud and the secretion retained, causing lameness. This is given as a reason why sheep should not be made to walk through mud. The writer has never seen such a stoppage. The secretion is not very abundant, and the movement of the foot would likely discharge any bits of dirt in a short time, before lameness would develop. Various functions have been ascribed to these secretions. It is stated that through it the grass becomes scented so that sheep that stray from the flock may later, through a very keen sense of smell, trace their way back. Others have said that the secretion represents waste products. Other glands are found in the groin.

The skin of sheep is much thinner than the hide of the cow. It is usually only from one to three millimeters in thickness, and it is easily torn. In dark-faced breeds of sheep the skin may be bluish or even black in color. When such pigmentation exists, black fibers are commonly found in the fleece. In the white-faced breeds the skin is pink in color when the animals are healthy. Many breeds have dark-colored muzzles and nostrils, but in some these areas are pink.

Features of the skin. The skin provides a covering for the flesh and a base for the elaboration of the wool fibers. It also is embedded with glands and helps in the regulation of the body temperature. The number of wool fibers per square inch of skin surface may vary from around 5,000 or less in the case of loose-fleeced individuals to 50,000 or more in those with very dense fleeces. With these variations there are also great differences in the size of the fibers. Diameters may vary from 0.0002 to 0.018 of an inch, and length, from about one inch to fifteen inches in a year's time. Most wool fiber growth is continuous. These matters are discussed more completely in Chapter 37.

Among the important glands of the skin are the sweat glands, which secrete water and some potassium salts. There are other constituents of perspiration produced by the sweat glands, which are found distributed over most parts of the body. Perhaps the most important glands in the skin of sheep are the sebaceous or oil glands, which produce the yolk or oily material found in the wool. The combined products of both the sweat and sebaceous glands are known as the yolk; the two are sometimes differentiated into yolk and suint. In this differentiation yolk is of most significance. The



Courtesy University of Illinois

The skeleton of the sheep consists of many parts and is the basic structure of the body.

sebaceous glands are usually connected with the follicles in the skin from which the wool fibers grow, and it is upon the fibers just beneath the surface that the yolk is mainly discharged. The glands are much more active in some cases than in others, and this, of course, results in some wool being very oily. This is especially the case in some Merino sheep.

The hoofs of sheep are usually black in color except in the case of those breeds that have pink coloration of the muzzle. As indicated in the tabulation at the beginning of the chapter, the hoofs of sheep are two-toed. Each toe is somewhat triangular in shape, and the outer part is covered with tough horn, which is a modification of the epidermis of the skin. When sheep are raised on soft ground, the outer wall does not wear off and may turn under, causing difficulty in walking. The toes sometimes grow very long also.

The skeleton. The general structure of the sheep is determined by the bony framework or skeleton. The external appearance of some parts is, however, dependent upon the muscles covering the skeleton. And the appearance changes further as the animal

fattens, for fat gives the body a smoothness and fullness surpassing that of thin animals. The shape of the head is almost completely determined by the bones. The muscles in this region, with the exception of those about the jaws, are not bulky. The foundation of the neck is the cervical vertebrae. These are irregular in shape and permit of great flexibility. There are usually seven cervical vertebrae; in all probability there are instances of both fewer and greater number. Some authors state that in the case of the cervical vertebrae the number is constant, but variations occur in all other aspects of the vertebral column. Differences in length of neck may be due to differences in the lengths of the individual bones or to differences in numbers or to both of these factors. The general shape of the neck is determined by the muscular covering. In rams this is very highly developed, while in ewes the neck may be long and slim because of a deficiency of muscling or the lack of hormones, which cause great development of the forequarters of males.

Thirteen vertebrae usually comprise the thoracic group. To these are fastened the thirteen pairs of ribs. Here, too, the numbers may vary, and sheep with twelve and others with fourteen pairs of ribs have been reported. Such variations would have a pronounced effect upon the general appearance. Of the usual thirteen pairs of ribs, eight are sternal or true ribs. These eight pairs have individual cartilages extending from the lower end to the sternum or breastbone, which makes up the floor of the chest between the front legs. Four pairs of ribs, called asternal or false ribs, have cartilaginous extensions, but these overlap and are fastened to one another rather than directly to the sternum. The floating or last pair of ribs is not attached to the sternum. Much stress is sometimes laid upon "the spring of rib" as an indicator of the capacity of the chest. There is considerable variation in the width and height of the arch of the ribs, but this feature is hard to determine, if indeed it can be determined, in fat individuals. Processes extend upward from the thoracic vertebrae, and these, too, vary in length. Such differences may explain why some sheep are "sharp" over the shoulders. The sternum is made up of seven sections. The cartilages of the ribs are attached to indentures in these segments.

The base of the loin is comprised of the lumbar vertebrae, of which there are generally six or seven. In some instances the upright processes on these vertebrae are much longer than in others. Likewise, the transverse processes which give the loin its width

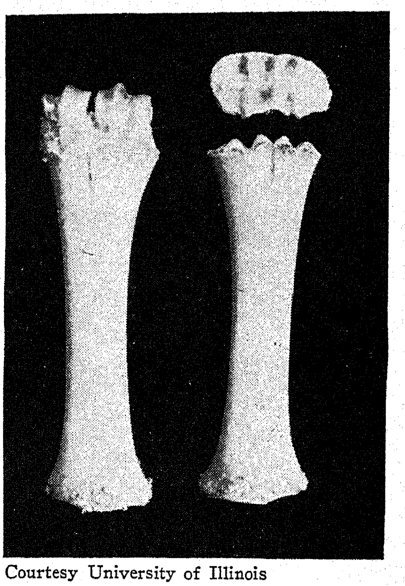
have various lengths in animals of different sizes and development. When these processes are covered with a thick layer of muscle and fat, the loin has great width. After maturity the skeletal changes are small, although there may be large changes in the thickness of flesh due to the loss or addition of fat within and upon the muscle fibers. The differences in lengths of the vertical processes and in the amounts of muscle and fat cause individuals to "handle" differently in the region of the loin. Much stress is laid on these items in the awarding of prizes to show animals.

The sacrum is composed of four sacral vertebrae which are fused into one bone. There may be some variation in the number of bones making up the sacrum. The lower side of the sacrum forms the upper wall of the pelvis. The pelvis is formed so there is little movement at the joint between the sacrum and the ilium, the upper projection of which is known as the point of the hip.

The skeletal base of the tail is composed of the coccygeal vertebrae. Here the number varies greatly. In some so-called tailless sheep there may be but four or five, while in long-tailed sheep the number may exceed twenty. In the process of docking most of the coccygeal vertebrae are removed.

The front and hind legs constitute the major remaining parts of the skeleton. There are great differences in these regions. The forelegs do not have any rigid or flexible skeletal connection with the other parts of the skeleton. The ribs and spinal column are suspended between the shoulder blades by strong muscles. This permits of great flexibility. It also helps explain much of the difference in the conformation of individual animals, for there are undoubtedly some in which the top of the shoulders is low in relation to the vertical processes of the thoracic vertebrae and others in which the opposite condition exists. Great differences exist, too, in the way the shoulders are held against the body and in the manner in which the legs are set in relation to the chest. A glance at a skeleton is helpful in understanding the reason for the differences in the relative values of cuts of meat from the forequarters and the hindquarters. The shape of the forequarters is influenced much more by the skeleton than is the shape of the hindquarters. To give the latter a fullness and plumpness of form, muscling must be very great.

The bones of the legs vary to extreme degrees in length, size, and in general placement. Much of the difference in height of body



Courtesy University of Illinois

The "break joint" is one means of estimating age in the meat trade: left, the round joint of a mature sheep; right, the irregular break joint of the lamb. The forelegs of young animals are severed at the break joint.

is due to differences in length of leg bones; considerable difference is also due to the size and depth of body. A shortening of the bones of the hindlegs is usually accompanied by an apparent thickening of the muscles; short-legged animals may have fuller muscling in relation to the amount of bone. It is doubtful if this is always the case. Long-legged sheep are able to travel faster than those with very short legs. In the leg bones just above the hoofs are found the epiphyseal or temporary cartilages which constitute the "break joint" used as a guide to the age of the animal's carcass in the meat trade.

Internal structure. Sheep belong to that section of the animal kingdom known as ruminants. Such animals are characterized by the peculiar structure of the stomach with which is combined such typical activities as regurgitation and cud-chewing.

Teeth are usually referred to as of two kinds by practical sheepmen. These are lamb, or temporary teeth, and second, or permanent teeth. They are frequently inspected in efforts to estimate the age and general condition of sheep. This procedure is discussed more fully later. There are 20 temporary teeth but 32 permanent ones. In both instances there are eight incisor teeth, which are all in the lower jaw. There are no teeth in the front part of the upper jaw, but there is a cartilaginous pad against which the lower incisor teeth press when the jaws are properly formed. In grazing, the sheep seems to tear the grass off by quickly jerking its head as the herbage is held between the teeth and the pad. In some instances the teeth extend in front of the upper jaw, and in others the lower jaw is so short that the teeth may impinge against the upper jaw back of the pad. There are many different degrees of

these undesirable jaw formations. These features are referred to as undesirable because they may be transmitted to succeeding generations, and they may interfere with the animal securing feed under some conditions. Back of the incisor teeth of the lower jaw and the cartilaginous pad of the upper jaw, there are spaces which are devoid of teeth. Behind these spaces are the premolar and molar teeth, which crush and grind the feed gathered by the incisors and other mouth parts. The "cheek teeth" are rough at the crown and are encased with a very hard enamel which wears down slowly, even though much of the grazing is done on herbage that contains a large amount of silica. It is a fascinating observation to notice the efficient way sheep move the lower jaw to one side and then reverse the direction of movement as they chew the boluses of food during rumination.

The stomach has four compartments. The oesophagus leads to the largest of the four divisions. This is the rumen, or paunch, which serves as a place for the storage of feed prior to its regurgitation for further mastication. The reticulum appears to be a continuation of the rumen; it has many hexagonal elevations, which give it a honeycomb appearance. Food enters this section, also, prior to its regurgitation. When the food is swallowed the second time, it passes along a groove into the third section of the stomach, which has been brought forward into a closer relation to the oesophagus during the act of swallowing. This section, the omasum, is the smallest of the four compartments and has many leaves extending through it lengthwise. It joins directly with the abomasum, or true stomach. Considerable digestive action occurs here. Efforts to measure the size of the various units are not very successful, for this is usually done by filling them with water, which is not the material with which they are filled naturally. However, for a sheep of about 150 pounds the capacities in quarts, as averaged from various sources, may be given as approximately 25 for the rumen, 2 for the reticulum, one for the omasum, and 3 for the abomasum.

Intestines. The principal gross character of the small intestines is their length, which is about 85 to 90 feet in mature sheep. This length gives them a very large area for the absorption of food nutrients. The capacity is roughly 9.5 quarts. The large intestines are about one-fourth the length of the small intestines, but they have approximately one-half the capacity of the latter. This is an extremely sketchy description of the structure of the intestinal

tract, but a detailed consideration is beyond the scope of this text.

Other organs. Sheep, like other animals, have many additional organs and tissues. Some attention is given a few, such as the reproductive system, later. The study of others, especially in detail, belongs to the fields of anatomy and physiology.

Body temperature. The average normal rectal temperature of sheep is 102.3°F., but the range is from 100.9 to 103.8°F.

CHAPTER 3

The Life of Sheep

Number of young. Lambs are produced as singles, twins, triplets, quadruplets, and quintuplets. Occasionally, the number at one yeaning may exceed five. Single lambs are produced most frequently, but it is not unusual for all of the lambs in a small flock to be twins or triplets. In many flocks a lamb crop of 150 per cent is expected each year. This means that approximately one-half of the ewes have single lambs, and an equal portion of the ewes have twins. The frequency of multiple births is an interesting phenomenon. The manifestation of this character shows great variation in the same ewes from year to year. Much of this variation is apparently due to the influence of environment. It is not a simple hereditary matter. The most extensive data on the frequency of multiple births involves 58,381 births.[1] Of these, 52.55 per cent were single lambs; 45.03 per cent were twins; 2.31 per cent, triplets; 0.10 per cent, quadruplets; and 0.009 per cent, quintuplets. According to this study the proportion of twin to single births is 1 to 1.2; of triplets to twins the ratio is 1 to 19.5; and of quadruplets to triplets, 1 to 22.5. Another report[2] shows that of the ewes producing 1,019 lambs, 36 per cent bore singles; 60 per cent bore twins; and about 4 per cent, triplets. Since very few ewes have more than two functional teats for the lambs to nurse, more than two lambs are generally not readily raised by the ewe.

Breeding habits. All but relatively few ewes produce lambs but once during a year. There are occasional ewes in all breeds that mate and produce lambs twice during a single year. There are certain breeds, especially the Dorset, that are said to differ so much from other breeds that lambs may be produced not only at unusual seasons of the year but that two lambings a year may be obtained by the producer with considerable regularity. There may be instances

[1] JOHANSSON, J. and HANSSON A. Annals of the Agr. Col. of Sweden. Vol. 11. 1943.
[2] CHAPMAN, A. B. and LUSH J. L. Jour. of Heredity. Vol. 23. No. 11. 1932.

Courtesy University of Illinois

This is a grade ewe and her quadruplets.

where this is true, but all Dorset breeders do not make such claims or consider the practice generally advisable even if obtainable. In some comparisons Rambouillets showed a stronger tendency toward out-of-season production of lambs than did the Dorsets.

The normal breeding season is in the fall of the year, but for the United States as a whole the season may extend from July until January. Since most ewes have only one season of the year during which they have regularly recurring estrus or heat periods, they are said to be seasonally polyestrous. Such periods cover about twenty-four hours with a recurrence at about seventeen-day intervals during a season of about five months if pregnancy does not develop. Rams will mate at all seasons of the year, but many of them have no capacity to fertilize ewes during the summer months. Apparently, this is due to the effects of summer temperatures, but there are individual and very probably some breed differences.

Newborn lambs. Lambs are born after a gestation period of approximately five months. They are recognized by their mothers

by means of the sense of smell. Apparently, this is the chief means of recognition between mother and young so long as the lamb suckles. The lamb and the ewe can at least partially recognize the call of the other, as all shepherds have witnessed when the two have become separated. Sight may serve as a means of partial recognition too, but there is always the confirming sniff whenever the lambs start to nurse.

Birth weight. The weights of lambs at birth show a large range. Some may weigh no more than three or four pounds; others may weigh fifteen to eighteen pounds, and there are apparently authentic cases of lambs, that were normal in all respects, that weighed more than twenty pounds at birth. While there are individual exceptions, it is the tendency for the largest ewes within a breed to have the heaviest lambs at birth, and ewes of the large breeds not only have bigger lambs but their lambs grow faster than those of the small breeds. The average weight of twin lambs is less than the average weight of single lambs. The average birth weight of all single lambs is probably in the neighborhood of nine pounds. Twin lambs usually differ in weight. Males are generally heavier at birth than females, whether singles or twins.

Growth. Growth is not simply an increase in size in the parts but involves also many changes in the proportions of various parts in relation to others. Growth is generally measured by weight and height, but these two measurements do not reveal many of the changes occurring during development. An astounding amount of growth occurs before birth, for in a short period two cells of microscopic size have united and enlarged until, as an average, a weight of about nine pounds has been attained. The rate of increase is rapid after birth if conditions are favorable. These consist essentially of an abundance of suitable food and freedom from disease because of a good environment. During growth, the outline of the body changes and so do the proportions of its tissues. The head is relatively large in the newborn lamb and becomes proportionately smaller as growth proceeds. The length of the body increases more than the height. It is along the back that some of the most valuable parts of the carcass are found, and this increase in length is therefore desirable. The various bones do not all grow to the same extent; for example, the cannon or shank bone grows much less after birth than the femur bone, which extends from the stifle or flank to the hip joint. The muscles, after birth of the lamb, grow to a much

greater extent than the bones which they surround, so that the proportion of muscle to bone increases as the lamb develops. The ratio of fat to bone increases still more than the ratio of muscle to bone, and there are, of course, very evident changes in the ratio of fat to muscle.

The growth of a lamb is by no means proportional in all respects. Young lambs are in many ways undesirably proportioned. The legs are likely to seem unduly long and the body rather shallow and narrow. The proportions of the newborn lamb are very well adapted to meet the physiological requirements attendant on birth and for a short time thereafter. Some of the differences are shown in Table 1.

TABLE 1

AVERAGE MEASUREMENTS AND WEIGHTS OF 62 SHEEP AT 14 AND 280 DAYS OF AGE[1]

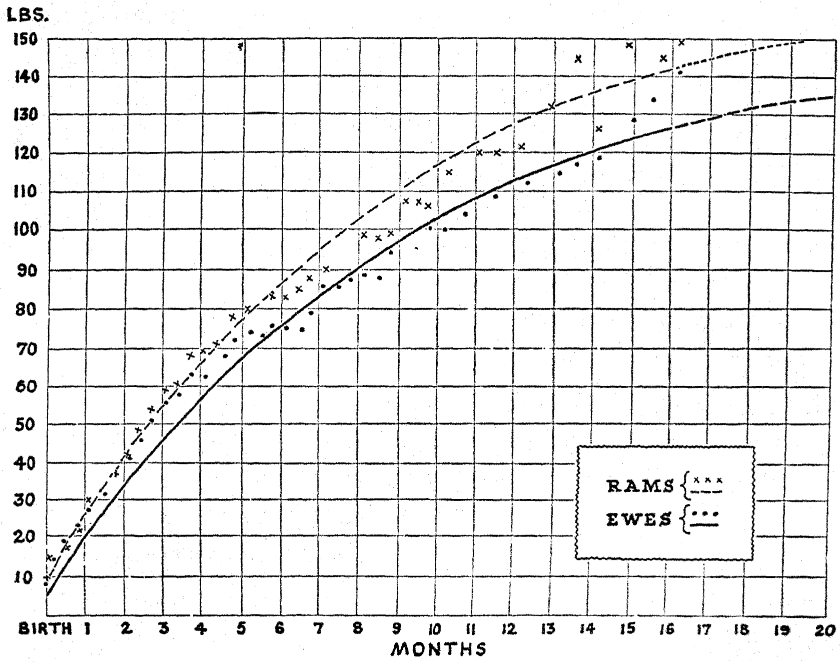
Item	14 days	280 days	Increase per cent
Weight, lbs.	15.2	68.7	352
Height, shoulder, mm	390	575	47.5
Head length, mm	115	175	52.2
Head width, mm	80	115	43.8
Neck length, mm	175	285	62.9
Trunk length, mm	320	525	64.1
Chest depth, mm	140	260	85.7
Chest width, mm	100	170	70.0
Loin width, mm	70	120	71.4
Rump length, mm	80	135	68.8
Foreleg length, mm	270	395	46.3
Hindleg length, mm	305	445	45.9

Growth rates show considerable variation in individuals. In general, the rate is most rapid for some time after birth, with a declining rate as maturity is reached. As measured by weights it does not seem that growth is uniform. The average growth rates of several hundred Shropshire lambs are shown in the accompanying chart.[2]

There are two rather striking peculiarities with respect to growth. One of these is the tendency for the skeletal framework to continue to enlarge even when the food supply is not constant or abundant. Likewise, efforts to stimulate the growth of the skeleton

[1] New Hamp. Agr. Exp. Sta. Tech. Bul. 14. 1919.

[2] Ill. Agr. Exp. Sta. data.



This chart shows a growth curve and observed mean weights of Shropshire ram and ewe lambs.

by an excess of food usually fail to develop such a response. Another peculiarity is the opposite effect with respect to the fleshy tissue. This increases or decreases promptly in relation to the food supply. There is a remarkable tendency for lambs to become plump and fleshy during the early stages of growth if they receive an abundance of their natural food—milk. Later, when the diet is composed of feeds of a bulky and fibrous character, the plumpness disappears, and it is difficult to re-establish the condition unless grain is fed. The fat that is accumulated during the period when milk is the chief feed of the lamb seems to serve as a reserve needed to make the change to coarser feed without too severely retarding development. A high state of flesh seems to be more essential for the lamb than it is for the well-being of the animal as maturity is approached. Since it is costly to maintain a high degree of fleshing, it is fortunate that a full, mature development can be attained without sufficiently heavy feeding to retain a large amount of fat.

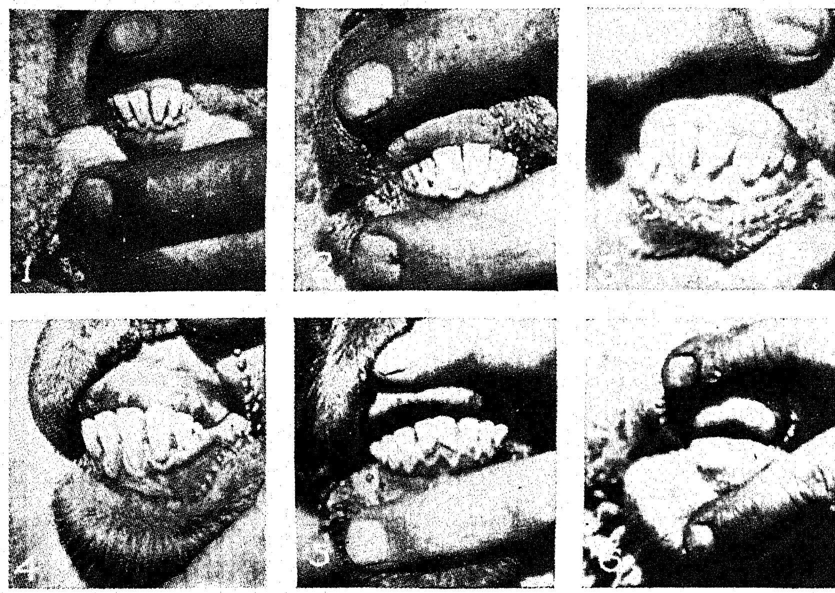
In fact, it is possible through long-continued high feeding to reduce the efficiency with which feed is utilized. Thus, in addition to the expense of such feeding, it may be harmful to the animal.

Age. Sheep are generally fully grown at two years of age. Some may attain full size of maturity at eighteen to twenty months; others may not complete growth until they are thirty months of age or older. Some breeds develop more rapidly than others. Sheep raisers generally regard the Merinos as being slower in reaching maturity than some of the mutton types. The rate of growth and the time at which growth may be completed are influenced by the manner of feeding and the conditions under which the sheep are raised. It is a common observation that sheep which develop very fast may have a shorter life span than those which develop slowly. Full supporting data for this belief are not now available, and the usefulness of an animal is not determined solely by how long it may survive.

There are various indications of age, among which are the general appearance and activity of the sheep. These things are influenced by unfavorable environment, poor feeding, inadequate care, and exposure to extreme weather conditions. Regular, continuous production also influences the general appearance. However, since this is not an entirely reliable guide to the future usefulness of sheep, other guides are used. Much of the value of an animal depends upon whether or not it can gather and utilize feed efficiently. Sheep raisers generally estimate a portion of such usefulness on the appearance of the teeth.

The teeth may be used not only to gain an approximate idea of the age of a sheep, but the condition of the teeth may be used as a point from which to decide whether an animal should be retained or discarded. Sheep that have lost most of their usefulness will show many irregularities of the teeth. The exact age of old sheep is not so important as the condition of the mouth or teeth. The examination of the teeth is limited to the incisors. This examination is made by merely separating the lips so the teeth may be seen. The mouth is not opened.

Lambs have eight incisor teeth. These are much smaller than the permanent teeth. In general, the central pair of incisors are replaced by permanent teeth when the age of twelve or fourteen months has been reached. After this change has occurred, the animal is not considered as a lamb but is designated as a yearling



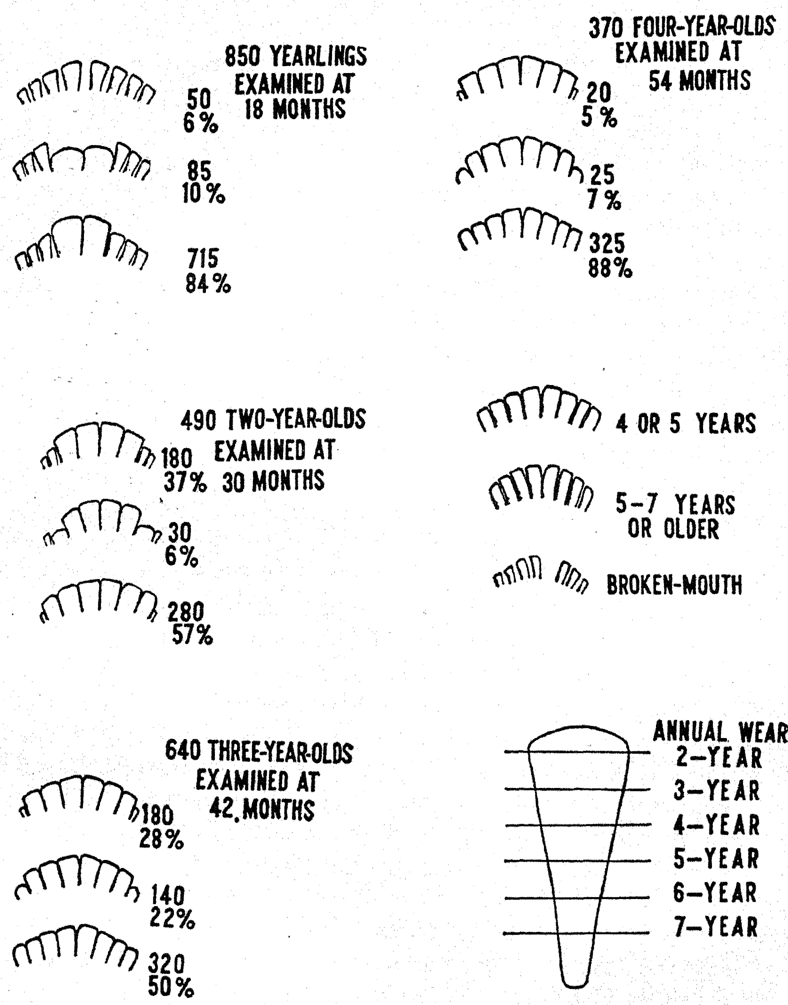
Courtesy R. F. Miller, University of California

The incisor teeth of sheep differ at various ages: (1) lamb, (2) yearling with two permanent and six lamb teeth, (3) two-year-old, (4) three-year-old, (5) four-year-old, (6) an old sheep that has lost all its incisor teeth (a gummer).

ewe, ram, or wether, as the case may be. In some areas such sheep are referred to as "two-tooth." On each side of these two broad permanent teeth are three small lamb teeth which are shed at later ages. The next pair is shed and replaced at the age of about two years, and the sheep is a two-year-old or a "four-tooth." Two more of the lamb teeth are replaced at three years, and the last pair is replaced when the animal has attained an age of about four years. After this time the age cannot be estimated with any degree of accuracy by means of the teeth. While many millions of sheep have been bought and sold on this basis of estimating the age, there are numerous departures from these age and teeth relationships.

The examination of 2,300 sheep of known age (all had been ear-tagged as lambs) revealed many departures.[1] The examinations were made in the fall of the year so that the sheep were in all cases midway between the time at which they should show changes in the

[1] Mont. Agr. Exp. Sta. Cir. 149. 1936.



From Montana Experiment Station Circular 149

There are variations in teeth within groups of sheep of the same age as well as variations in teeth with sheep of different ages. Changes in the teeth of sheep are not regular and serve only as approximate indications of age.

teeth. The findings are shown graphically in the accompanying chart.

According to this study one could pick out all of the yearlings and 43 per cent of the two-year-olds. Fifty-seven per cent of the two-year-olds and 28 per cent of the three-year-olds had the same appearance of the teeth, as they all had three pairs of permanent teeth and one pair of lamb teeth. It was found that at an age of 42 months, 22 per cent of the three-year-olds were just cutting the fourth pair of teeth. But 50 per cent of the three-year-olds and 88 per cent of the four-year-olds looked just the same. From this study and from extensive observations in addition, it is evident that teeth do not change with the regularity often supposed. After the age of four years, the age can only be estimated in the most flexible fashion. The width of the teeth, the extent of wear, and the firmness in the jaw may be considered. The incisor teeth are wedge-shaped, and they wear down from the time they are erupted. As they wear down they move outward from the gum, and thus sheep are known as "spreaders" when the teeth show some space between them. When all of the teeth are present and close togther, they are "solid mouths." When some of the teeth have been lost, they are known as "broken-mouthed"; if all are gone, they are called "gummers."

Many other terms are used in reference to the age and sex of sheep. In some places a yearling ram, for example, is a "shearling," and a two-year-old is a "two-shear ram." These, of course, refer to the number of fleeces obtained in relation to the age. In England and some other countries a ram is often called a "tup," and terms such as "ewe-teg," "hogget," "hoggets wool" are often found in foreign publications. "Hoggets" are uncastrated young sheep, and "hoggets wool" is the same as lamb wool or that from the first shearing. Before the first shearing, ewes may be known as "ewe-tegs" or "ewe-hoggs." "Cast ewes" are "drafted" and sold to the butcher. A "crone" is an old "broken-mouthed" ewe.

The break joint, referred to in the preceding chapter, may also be used as an indication of age differentiation between young sheep and those which have passed the stage when the joint may be broken. This joint in young animals may be felt as a slight prominence about a half inch above the ankle. The region is smooth when the joint has ossified or become thoroughly hardened.

How sheep feed. Sheep require bulk in their ration, and since they feed largely on pastures and harvested roughages, this

requirement is readily met. They prefer short, immature grass to the very tall, rank-growing species or that which is mature. In grazing, they are prone to eat the forage very closely in some areas before they eat the more abundant growth on other parts of the area. They nip the leaves from many of the plants, leaving the coarser stems, although in some cases they eat the stems of large plants. Sheep eat many varieties of weeds and browse, but they are not so fond of the latter as are goats. While they graze on high grounds, they are also very fond of the plants that grow on the lower levels. They tend to travel around the slopes as they graze, but they frequently move directly up or down slopes. In a study of the activities of sheep on the range,[1] it was found that they start to feed early in the morning, graze for several hours, lie down during mid-day, and begin grazing again in the later part of the day. This, of course, has been observed by all those who have watched sheep on farms or ranges. In the Texas study, sheep spent about 50 per cent of the time feeding.

Bedding down. Sheep lie down as night comes on and do not continue to feed during the dark. There are exceptions to this procedure, but this is the general practice of flocks. In bedding down for the night, sheep generally seek a high place in the pasture. During the hot days of summer most breeds seek shade. There are some differences in breeds in the way they forage during very warm weather. Sheep do not seek shelter from cold unless it is extreme and accompanied with storms. Often they lie outside of the shelter, especially if the ground is dry.

Drinking. Sheep are among those animals that can exist for a long time on relatively small amounts of water. They may, however, drink regularly when a supply of water is available, even in cold weather if the water is not too cold. Sheep seem to have a decided preference for running water. The daily consumption is from one to four quarts, depending upon the temperatures of the weather and water and on the kind of feed. Probably one of the reasons why sheep require less water than some other animals is that there is no loss, of consequence, through perspiration.

Flocking tendency. Sheep have a tendency to stay together in groups. This is gregariousness, but the instinct is more marked in some types and breeds than in others. This flocking habit is a very useful characteristic in the handling of sheep where they are

[1] Texas Agr. Exp. Sta. Bul. 367.

herded on the open ranges. Those breeds which have the least tendency to stay closely grouped are much more difficult to herd than breeds such as the Merinos and Rambouillets, which have the most pronounced gregariousness. Some breeds, such as the Cheviot, scatter individually or separate into small groups rather than staying in one large band. When frightened, all sheep gather into one group. In herding sheep on the range, it is one mark of a good herder to have a "good spread" to the flock; that is, the group while together has considerable space between members so that all have a good chance for grazing. The flocking instinct of the fine-wool breeds is generally well developed in crossbred sheep which carry some fine-wool blood.

Experienced sheepmen know that a sheep off by itself is usually ailing in some respect. In many areas those that stray away are easy prey for predatory animals.

Along with the flocking instinct, sheep have a strong tendency to follow a leader. This tendency is used in many practical ways. Many lambs are loaded into railroad cars and moved from one place to another by leading a sheep or goat ahead of them. Goats and sheep are sometimes specially trained for such leading duties. An understanding of these traits of sheep makes the handling of them much easier.

Fence requirement. Sheep are relatively easy to confine as they do not require such heavy fences as other stock, but the fences must be well built and the wires must be close enough to keep them from walking through. A few sheep will jump low fences but, generally, only when frightened.

Self protection. Sheep are perhaps the poorest equipped of any domesticated animals for their own defense. Even those breeds which have horns are unable to ward off attacks of vicious predatory animals. Predators are found in all countries. In most countries the chief enemies of sheep are wolves, coyotes, bob-cats, mountain lions, or kindred animals of the dog and cat. Some birds of prey attack sheep, especially lambs.

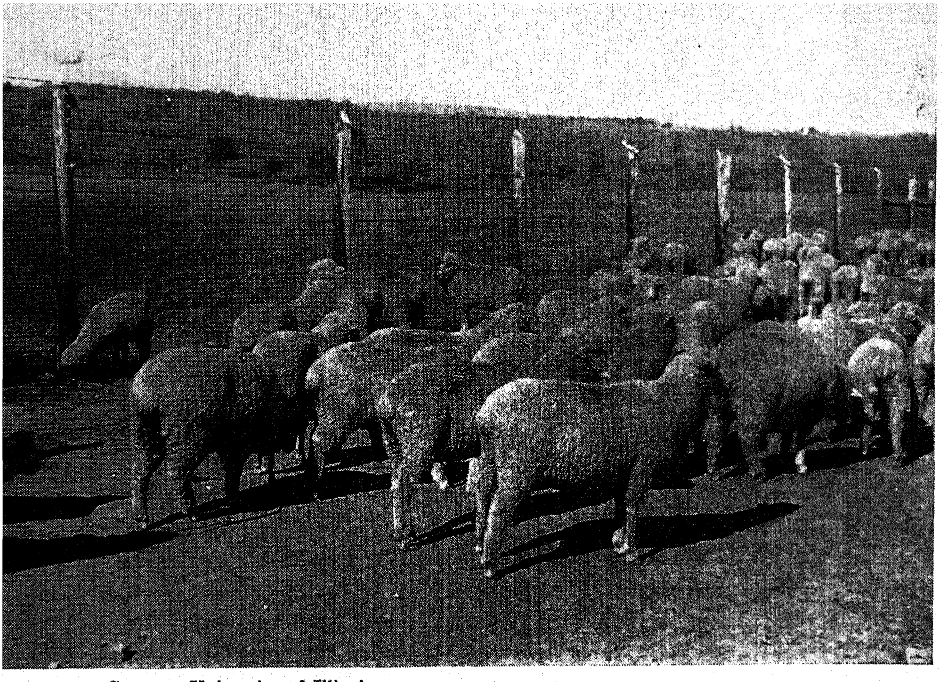
In many communities the worst hindrance to sheep raising is the dog. While dogs, like other predators, may kill sheep, much of the harm which they do to sheep is in the form of injuries, exhaustion, and fright. Many deaths follow serious injury and exhaustion after a chase by predatory animals. The sheep's main means of defense is in flight, and this, of course, is of little help when there is

an attack by wolves, dogs, or similar animals. The skin of sheep is easily torn, and injuries to the flesh are often very deep. Wounds become fly struck and infected, and much treatment is required to heal them.

There have been many suggestions regarding the protection of the flock from dogs. Corralling the flock at night in a dogproof enclosure is one means, but this does not allow the flock the freedom which it should have for best results. The use of bells on a considerable percentage of the flock has some beneficial effect, but this will not stop a pack of vicious dogs. The use of goats with the flock may afford a slight protection, but many goats are also killed by predatory animals, including dogs. Recently, some effort has been made to develop substances which have an odor that will repel dogs. At this date the substances have not been thoroughly tested, although there are materials which are extremely distasteful to dogs, and the idea is worthy of some study.

Many states have enacted laws designed to assist the sheep raisers in their efforts to prevent their flocks being destroyed by dogs. For the most part these laws make the dog owner responsible and levy taxes on dogs. Such sums may be used for the payment of losses which may be caused to sheep or other stock or poultry. While these are helpful, the enforcement of dog laws is not such as to give the needed protection and assurance. Some serious outbreaks of rabies in sheep and other animals have been caused by dogs. The classification of dogs as domestic animals and making them subject to confinement would be a helpful step in many states. Farmers' Bulletin 1268 of the United States Department of Agriculture contains a summary of the dog laws of most states in this country. Trapping, hunting, and poisoning are used by rangemen as defenses against wolves, coyotes, and other predators. In many of the range states bounties are paid to those who kill various predacious animals. In some states hunters are employed by the governmental agencies to help in control measures.

Diseases. Illness in sheep is not readily detected by many people. Many diseases of sheep have a very rapid course, and if symptoms are not noticed at the onset treatment is not likely to be successful. Until comparatively recent times the diseases of sheep had not received as careful study as the diseases of other animals, and treatments had not been so well developed. Research work has resulted in the development of efficient treatments for some diseases,



Courtesy University of Illinois

Profitable flocks are maintained by health-promoting management practices. These well-nourished ewes are the foundation of a healthy flock.

and, what is of far more consequence, preventive measures have been developed. Despite the common saying that "a sick sheep is as good as dead," it is doubtful if the losses of sheep are greater on a percentage basis than occur in some other farm animals. Some types and breeds are probably more resistant to disease than others, but none are immune to all. A later chapter is devoted to this problem.

CHAPTER 4

Types and Breeds

Although there are at the present time many breeds of sheep in this country, none of them are indigenous. Most of the breeds were developed in England, but several of much importance originated in Spain, France, Australia, and New Zealand. Recently, breeds have been developed in this country for rather specific purposes, but the foundation stock came from other countries. Only one breed from Asia, the Karakul, and one from Africa, the Tunis, are found in the United States. Brief descriptions of almost two hundred breeds in various parts of the world were given in a journal [1] devoted to sheep raising, but less than twenty-five breeds are raised in this country. Many of these breeds are of little consequence in commercial production, and more than three-fourths of the industry is based on the use of not more than six breeds. It seems probable that the industry would be benefited if some breeds were eliminated with the object of bringing about greater uniformity in its products.

Adaptation of breeds. Many breeds do not have any special usefulness not possessed by others, but there is a rather widespread conviction that some are peculiarly adapted to conditions within a certain area. This is the impression gained from a study of sheep raising in England, where breeds are restricted to rather limited areas. Breeds which have been raised in the hill country of England for many years are not considered suitable for lowland regions, and lowland sheep which are larger than those of the hill sections are said to require "stronger" feed than is usually available for hill sheep. Other matters enter into these considerations, and it does not appear that any breed is found in all parts of England. Many of the hill sheep are, however, transferred to the lowland areas for fattening or for use as breeders after they have attained an age beyond which they are not considered able to perform satisfactorily

[1] Sheep and Goat Raiser. No. 3 of Vols. 21, 22, 23, 24, 25 in 1941, 42, 43, 44, 45.

on the sparse feed of the hill lands. There are many instances of similar transfer from the range sections of the West to the farms of the Central States in this country. There are many different conditions in this country, too, and it is not contended that all breeds of sheep are equally well adapted to various conditions.

Many of the choices of breeds have been made on the basis of prejudice rather than fact. For the most part commercial lamb and wool growers have been more often guided by facts than have some of the producers of purebred animals. Breed promotion among commercial growers on the basis of propaganda rather than on production records within localities has not been successful for any long period. When commercial producers have tried a breed, but it has not performed satisfactorily, it has been discarded.

Wool breeds. Many facts relating to wool have been revealed by research. These facts show that some types of sheep which were at one time considered superior as wool producers are, in fact, less satisfactory than others. This condition arose because of the emphasis upon features which have no established relationships to woo production. Such features as extreme wool covering about the face, folds in the skin, and excessive secretion of yolk, formerly considered desirable in wool-producing breeds, are now known to be detrimental to superior wool production. Because a sheep of any breed is of little value for meat does not establish its suitability for wool. Neither does the failure to produce wool reasonably well reveal any desirability in meat production. However, certain breeds lacking in one respect may be useful for crossing with others for either lamb or wool raising. Much crossing of this kind is done in the western range sections.

Meat breeds. Claims with respect to meat production are based largely upon the appearance of the animal. Some breeds are certainly superior to others in meat production, but there is no thoroughly established basis on which to choose between specimens of breeds before slaughter. Slaughter makes possible the determination of the dressing percentage and other features of the carcass. Some features of the carcass can be compared in live animals with reasonable accuracy, but others cannot be. This is the reason why in expositions the winners in the live classes are seldom the winners in the carcass classes too. The standards of the two classes differ, but it is likely that research will reveal methods of greater accuracy than those now used so that agreement will be more general.

Since sheep cannot now be raised profitably in this country for wool alone, there is increased emphasis on breeds of the meat or mutton type. Thus, it is likely that the breeds which predominate in the future will have many similarities with respect to form and general type, but there will be differences in size and in those features by which one breed is distinguished from another. To be an acceptable specimen of a breed, the animal must possess what are termed breed characteristics. These are features such as color of the face, legs not covered with wool, the extent of wool on the head, the size, shape, and carriage of the ears, et cetera. Unfortunately, in some breeds the development of these breed characteristics has been emphasized to such an extent that little attention has been given to other matters that have far more relation to the pro ductivity of the individuals. And still more unfortunately, some features that have become associated with a breed's characteristics are definite detriments to its usefulness. In some cases breeders have persisted in the continuance of such features for so long that much of the breed's practical usefulness has been lost. The student will find the facts about a breed to be between the claims of the overzealous and the criticisms of the disparagers.

Breed classifications. Breeds of sheep are classified on several different bases. Sometimes the classification is based on the degree of suitability for meat or wool production, sometimes on the color of face, sometimes on whether or not they have horns, sometimes on general topography of the area where they originated (mountain, upland, and lowland), and sometimes on the type of wool. The latter classification is perhaps as suitable as any. On this basis the leading breeds found in this country are separated as follows:

1. *Fine-wool*	2. *Medium-wool*	3. *Long-wool*
a. American Merino	a. Southdown	a. Lincoln
b. Delaine Merino	b. Shropshire	b. Leicester
c. Rambouillet	c. Hampshire	c. Cotswold
	d. Oxford	d. Romney
	e. Suffolk	
	f. Dorset	
	g. Cheviot	
	h. Corriedale	
	i. Columbia	
	j. Panama	
	k. Romeldale	
	l. Tunis	

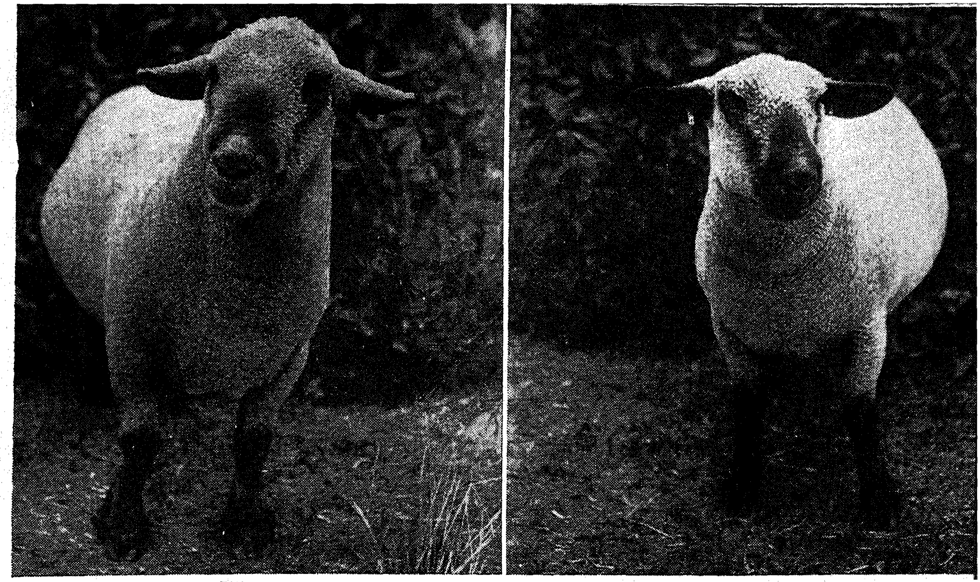
The Karakul is a specialty breed which does not fit into any of these groups. Some of those listed, such as the Tunis, and some not listed, such as the Black-faced Highland, may be variously classified.

In any classification there are only similarities in some respects. In other respects there are great differences. Thus, the breeds classed as fine-wools do not produce wool that is similar in all respects. But they all produce wool which is generally sold as fine-grade wool despite the differences that exist. There are many differences in the wool of the breeds classed as medium-wool. The wool of some is not more than an inch or two in length, while that of others in the group may be five or six inches long for the same period of growth. Differences of equal magnitude exist in other respects also. Indeed, even within a breed there are wide differences.

Sex differences. Some of these variations within a breed are associated with sex. Sheep raisers often mention the variation in masculinity among rams; and the marked differences between rams and ewes are well known. These differences are developed as a result of the presence of the primary sex organs and the production of various secretions by them. Many studies of the effects of the removal of the organs and the injection of various hormones have shown the remarkable effects produced by these substances.

Masculinity. This feature is emphasized particularly in rams selected for use in purebred flocks. It is not overlooked in rams to be used as sires of grade lambs. Masculinity is often considered as an indication of marked fertility and the ability of a ram to transmit his characteristics to his offspring. Genetic studies, however, do not reveal any certain relationship in either of these respects, for the development of masculine features is not related to fertility or the production of sperm cells but results from the hormones secreted by the male sex organs. These are not concerned in the transfer of characteristics from parent to offspring.

Masculinity does, nevertheless, have certain values. Masculine rams are generally aggressive and active, and there is a pleasing quality about their appearance which the ram lacking masculinity does not possess. Masculinity in rams is shown by boldness and ruggedness of head features, a strong muscular neck, and massiveness of the forequarters. The head of a masculine ram shows a rather large mouth, big nostrils, and an increased width just above the nostrils. This is commonly called the knob. The eyes are large and



Courtesy University of Illinois

This ram and ewe show the usual differences in secondary sex characteristics.

prominent with a look of daring. There is great width between the eyes and ears, back of which the neck is very strong and thick. This part is sometimes spoken of as the scrag. The neck is very muscular and swells into the shoulders without a noticeable depression. The forearm and leg bones are strong and set wide apart. The body is heavily muscled, and great strength is evident in all its parts. Because of the great development of the forequarters, the hindquarters may appear relatively lighter than in less masculine individuals. The voice is very deep. Well-developed sex organs complete the requirements of masculinity.

Femininity. This feature exhibited by ewes is quite the opposite of masculinity. It is manifested by general refinement and a lack of great forequarter development. The head features are smaller, and the neck lacks the heaviness of the neck of the ram. The eyes have much less prominence, and the impression one gets from the head is of a matronly quality because of the mildness of the expression of the face. Delicateness and weakness, such as might be shown by very small bone, are not, however, indicative of femininity but show lack of sturdiness which the regular-producing ewe must have. Feminine ewes have large roomy bodies with considerable length, and there is a complete and large development of the mammary system for the nourishment of the young. Ewes that fail to own their lambs should be considered as lacking in essential qualities of the female.

"Staggy" ewes are those which have some of the features usually seen in rams. Such ewes are generally poor breeders and hence are unprofitable. Often they do not breed regularly, fail to own their lambs, and are unsatisfactory in milking qualities.

Wethers. The castration of males when they are very young has a marked effect upon the later development. The features of masculinity do not develop nearly so fully as in rams, but wethers do not have the appearance of refinement seen in ewes. Wethers are more desirable from the market standpoint than either ewes or rams, but as lambs on the market there may be no distinction between wethers and ewes.

Breed descriptions. The various breeds are described in detail in the following chapters. These descriptions are concerned with the average of the breed, from which there are many departures. Some specimens vary so much from the breed standards that the association established for the recording of the purebred animals may refuse to accept such specimens for registration. These disqualifications, however, relate more to the awarding of prizes in show rings than to recording in the association. Relatively few specimens of the breed resemble closely the perfection sometimes found in the leading prize winners at the nation's shows. There is, however, no question as to which breed most purebred animals belong. It is important that students realize that extreme differences exist among purebreds. Specimens of the breeds should not only possess to a satisfactory degree the distinguishing characteristics of the breed to which they belong, but they should also be superior to the average non-purebred in the features of utility.

Breed history. Only brief attention is given to the history of the breeds in the following chapters. This is not a reflection on the importance of history; it is an emphasis upon present conditions which are of more immediate concern to the producers of sheep than events that occurred many years ago. In studying a breed, emphasis is put on how its various features are related to present-day production needs and market demands, and little or no mention is made of the leading breeders, either past or present. Prominence in the field of purebred production is attained largely through success in the show ring. The show ring is not designed to bring out the relationship between breed characteristics and production. Further, the winning of a prize does not in any way change the productive powers of an animal from what they would be without such

awards. Prize-winning rams and ewes may, however, possess exceptional features of production; and since shows serve as a prominent means of advertising, animals that achieve awards have the attention of many breeders directed to them. Prize awards reflect the momentary approach to perfection of features influenced chiefly by environment (feeding, fitting, posing, et cetera) rather than reflecting a definite and accurate appraisal of future breeding capacity.

The general histories of breeds have many points in common. Those breeds which were developed in England came chiefly from two general types. One of these was the long, coarse-wooled type which was found in the lowlands of the Lincoln, Leicester, and Gloucester areas. These were fairly rapid-growing sheep, but they did not mature early with respect to market finish. Market condition was generally attained after growth was fairly well completed. The faces and legs of this general type were white, although many specimens showed dark spots on the face, and the nostrils and hoofs were black. From this type were developed a number of breeds in England, some of which have been brought to this country. This type is represented in England by such breeds as the Cotswold, Lincoln, English Leicester, Border Leicester, Romney Marsh, Devon Long Wool, Wensleydale, South Devon, and others. The first five of this group have found some place in the United States, but they have declined in importance in recent years.

The other type differed greatly from the coarse, long-wool type. It was much smaller, had finer, shorter wool, and the fleece was lighter in weight. The fleece of the first type might weigh ten or twelve pounds, but that of the latter only five or six pounds. The face and leg color of this type varied from white to gray or black. Some specimens had mottled or speckled faces and legs. These sheep were adapted to regions that were quite unsuited for the coarser, larger type. Because they possessed features with respect to growth and fattening, and their wool was more desirable for many purposes, the breeds developed from this foundation are most numerous today. The Hampshire, Suffolk, Shropshire, Southdown, Ryeland, Dorset, and others were evolved from this general type.

Crossing of these two types was followed to a considerable extent, and some recognized breeds were developed as a result. The only one to attain prominence in this country is the Oxford. Some breeds were developed as a result of crossing strains within a type.

The strain which was developed into the Southdown breed was also used either prior or subsequent to the development of the Southdown in the formation of the Shropshire, Suffolk, and Hampshire. In this work various differences were emphasized in the selections.

Besides these types from which the prominent breeds of England were developed, there was the fine-wooled type of Spain. This type has probably had a greater influence than any other upon the world's commercial sheep industry. The type is represented in this country by the American and Delaine Merinos and the Rambouillet. Australian, South African, and South American sheep raising have been greatly influenced by sheep of this type. Several breeds which are now prominent in this and other countries have been evolved through the crossing of the fine-wooled and the long-wooled types. The Corriedale, Columbia, and Panama breeds are examples. Other efforts in breed development through the use of the fine-wool type are represented by the Romeldale of California and the Dishley Merinos of Europe. Many crosses of the smaller medium-wooled type with the fine-wooled type have been made, but no breeds have been developed as a result.

Grades and crossbreds. Millions of the sheep in this country are not produced by one breed alone. The great percentage of sheep are grade or crossbred, and, while they may show some of the characteristics of one breed to a greater degree than they show the features of other breeds, they are selected solely on the basis of usefulness for the purposes of the producers and of the market. Grade sheep such as these are sometimes referred to as of less significance than purebreds. In many individuals this is true, but, from the standpoint of the industry, grade and crossbred sheep are of great significance. Since the breeding of grades is not restricted within a certain group, efforts toward further improvement may be made through the introduction of any type or breed that may lead to such improvement. Improvement of purebreds, however, is expected to come from within the breed. From the standpoint of utility this may not always be a wise policy.

CHAPTER 5

The Southdown

The Southdown is generally credited with being one of the oldest breeds of sheep. Efforts toward the improvement of the native sheep found in the Southdown area of southern England were begun many years ago, and the development has been such as to give the breed a consistency with respect to type that is equaled by few other breeds. There is variation in type and in other characteristics even at the present time, but much of the variation is with respect to size, as all breeders have emphasized meat-producing qualities. Although the Southdown was used in the establishment of some other breeds, it seems unlikely that any sheep found outside its native home has been introduced as a means of improving the Southdown during a period of almost two hundred years. While much of the herbage of its native home was sparse and fine, the breed is not limited in usefulness to such conditions, and while it is the dominant breed in only a few areas, it is known in practically all sheep-raising lands.

Form. The chief purpose in the development of the Southdown has been to attain perfection of form and quality of carcass. The best specimens of the breed now closely approach the ideal mutton type in form. The body is compactly made, and there is exceptional fullness of the hindquarters together with a smoothness of outline few specimens of other breeds equal. The body is oval or rounded on top, is wide and deep, and is covered with firm flesh. The legs are short, which, with the other features, give the best specimens a symmetry that is unsurpassed. The general outline of the Southdown shows a rotundity which is enhanced by the arch of rib, smoothness of hips, shortness of neck, fullness of twist and flanks, and the wide-set legs.

Size. The Southdown is one of the smallest of the breeds. Mature rams in breeding condition weigh from 175 to 225 pounds and mature ewes, from 125 to 160 pounds. The weights of Southdowns

Courtesy University of Illinois

The smooth rounded body of the Southdown is shown by this shorn ram.

are often greater than anticipated by those who are not familiar with the breed. But the lack of size has been one of the main criticisms of the breed from the standpoint of the commercial producers. Those who have used the breed for commercial production have favored the larger animals, but breeders of purebreds have emphasized other features more. It is lack of size which has kept the breed from being used by the rangemen of the West.

Wool. The Southdown is not a good wool producer from the standpoint of quantity. Few mature ewes in a period of twelve months will shear more than five or six pounds of wool. The wool is relatively light in shrinkage (loss of weight in cleaning) as the amount of grease or yolk is small. The Southdown produces the finest wool of the medium-wool breeds, and it seems to be particularly well suited for use in hosiery. The wool will usually grade as three-eights or half blood with respect to fineness. The fibers are usually short, seldom attaining a length of more than two inches in a year's time on mature sheep. The fleece often does not cover the underline well. The fleece grows dense and compact, but its light

Courtesy American Southdown Breeders' Association

This group of Southdown ewes shows head and body features typical of the breed.

weight is very probably due to the lack of covering on the underline, shortness, and low grease content. Occasionally, some animals have dark fibers in the fleece. The wool extends to the knees and hocks in most mature individuals, but in lambs the legs may be covered to the pasterns. On the head, wool extends over the forehead, and there is a slight growth on the cheeks. All except very few breeders have sought not to impair the usefulness of the breed by having a full covering of the face to the extent of causing wool blindness. Lambs may show a greater covering on the face than mature sheep. Hairy or extremely coarse wool is sometimes found on the thighs.

Characteristics. The preferred color of the face and legs is perhaps best described as a steel gray, but there is considerable variation, and the color of these parts ranges from a light gray to a brownish hue. Sometimes the color is described as a mouse brown, but anything which is distinctly of a dark-brown cast is disliked by most breeders. The ears are the same color as the face, and the backs of the ears are generally covered with very short tufts of wool. Breeders dislike ears that are "slick" (devoid of wool or hair) and that are large and heavy. The preferred carriage or set of the ear is just a trifle above horizontal, and the tip should be rounded rather than sharply pointed. The nostrils are dark-colored. The face is short and broad, and both rams and ewes are hornless. Horns or scurs are sometimes found on rams, but these are very objection-

Courtesy University of Illinois

Many market-lamb producers prefer a large-type Southdown ram for use on grade ewes.

able. In nearly all specimens that are in good health, the skin has a delicate pink color.

Utility. The Southdown has many things in its favor which tend to offset the criticisms with respect to its size and light-weight fleeces. In point of early market maturity the breed is in first place. The lambs have a strong tendency to retain the milk fat and hence reach market condition at light weights, or they may be fattened later at heavier weights. This early maturity is accompanied by somewhat slower growth rates than is true of some of the larger breeds. The lean meat is fine-grained and juicy, and the fat is white and flaky. The plumpness and fullness of the carcass and of its various parts make it very attractive to consumers of lamb. The carcass is a decided favorite in areas where small cuts are demanded. The breed is exceptional with respect to the number of winnings in fat lamb and carcass competition.

For crossbreeding, the Southdown has been popular in some areas, notably in Kentucky, in this country. Other breeds are used

for crossbreeding purposes on the western ranges, despite the fact that the lambs by Southdown rams from either fine-wool or crossbred types of ewes grade higher both alive and dressed than lambs by other breeds of rams. This decision not to use Southdown rams is due to the greater weight secured in the lambs by the use of larger rams. In the hothouse-lamb areas the Southdown sire is preferred. Lambs by Southdown rams bear a close resemblance to their sires in many respects.

Prolificacy is not an outstanding feature of Southdowns but the number of lambs per hundred ewes may be expected to range from 125 to 150 or more. The ewes are average in milk production, and most suckle their lambs well. The lambs range from about five to nine pounds at birth and in most flocks would weigh an average of about 75 pounds at six months of age. Some are, of course, much heavier. After reaching maturity, Southdowns tend to remain fat and in good condition on average farm feeds. They are, therefore, more likely to get on their backs on uneven pasture land than some other breeds. If they remain in this position long—perhaps an hour or more—death results.

Standard of excellence. The Southdown Breeders' Association has published a standard of excellence for Southdown sheep in which the items are listed and described as follows:

GENERAL APPEARANCE. Short-legged, thick, spirited and attractive, with a proud and firm walk.

Mature rams in good flesh from 175 to 200 pounds and ewes from 125 to 150 pounds. Fitted mature rams and ewes from 10 to 30 pounds heavier.

Head. Broad and short. Masculine in rams and feminine in ewes, hornless and carried well up.

Face. Rather short and not too tapering. Color of a uniform gray or mouse brown. Well covered with wool but not to the extreme.

Eyes. Large, clear, and fairly prominent.

Ears. Medium size, oval, wide apart, covered with either hair or short wool, and carried in an alert manner. Color to match face and legs.

Neck. Short, muscular, free from wrinkles, and smoothly blended into the shoulders.

Shoulders. Wide, compact, neatly laid on top, and level with back.

Chest. Wide and deep. Brisket well extended.

Fore-legs. Short, straight, strong boned, and standing wide apart. Covered with wool down to the knees and a fair covering below the knees. Color to match the face.

Back. Straight, wide, strong, and heavily muscled.

Loin. Wide, level, and thickly muscled.

Ribs. Widely sprung, deep, wide and smooth through chest.

Rump. Carried out level, wide, and smoothly turned.

Tail or dock. Thick, meaty, and well set up.

Hips. Wide apart and smoothly covered with flesh.

Hind legs. Short and strong, standing wide apart, and covered with wool down to the pasterns. Color of pasterns to match the face.

Pasterns. Both front and hind fairly short and strong.

Thighs or hindquarters. Full and deep down in the twist.

Hoofs. Both front and hind dark in color and feet sound.

Belly. Straight, covered with wool, the flanks, both fore and rear, extending down, so as to form a line parallel with the top line or back.

Skin. Pink, bright, and healthy.

Scrotum. Good size, well hung, carrying two normally well-developed testicles, and covered with wool.

Fleece. Compact and uniform quality over the entire body. Wool of one-half and three-eighths blood of both the combing and clothing grades (56's-58's-60's). Color white and carrying sufficient yolk to keep fleece in good condition. Combing wool preferred at twelve months' growth.

Disqualifications:

Horns or evidence of them.
Dark poll.
Speckled markings on face, ears, and legs.
Color of face and legs approaching black.
Open or coarse wool.
Only one testicle down in the scrotum.
Too dark-colored or black skin.
Black or brown fleece.
Black spots on face, legs, or body.

Distribution. In spite of the fact that the Southdown is apparently well adapted to many sections of this country, it is among the less numerous breeds. Occasional flocks are to be found in many of the states, but, outside of Kentucky and some surrounding states and in the northeastern states, numbers are few. This condition is due to the commercial sheep raiser's dissatisfaction with the breed's

small size and its light fleece. Up to this time markets in this country will not pay a premium for the extra quality of the Southdown which is considered sufficient to offset the extra weight secured with some other breeds. The breed is popular in its native home, England, and has been exported to several countries. A few are still imported each year to the United States.

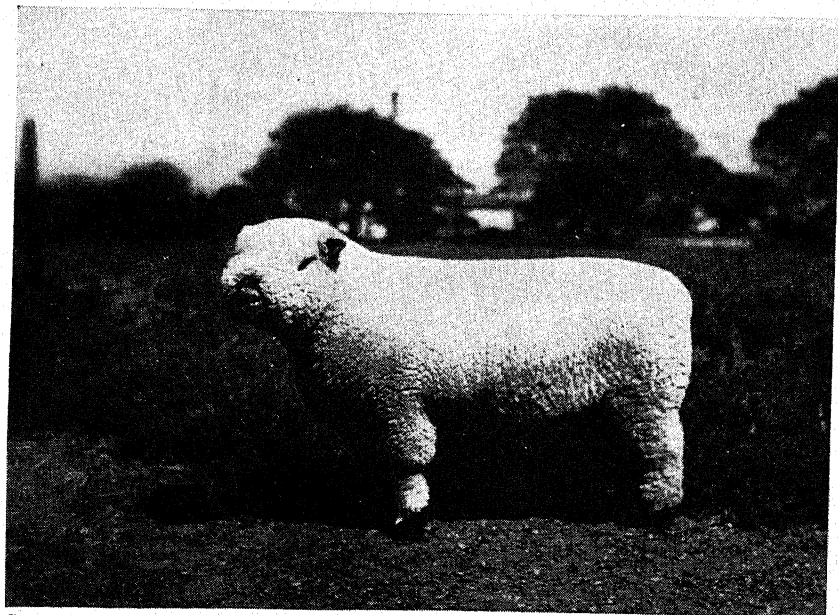
Registration. The American breeders organized an association for the promotion of the breed and for recording of the Southdown sheep in 1882. The society was reorganized in 1922. Its offices are now located at Pennsylvania State College. The publication of volumes of pedigrees has been irregular. At the end of 1945 about 170,000 had been recorded. The English Southdown Society annually publishes a volume entitled "The Southdown Flock Book." Few individual sheep are recorded in England except stud rams and ewes that are sold for export. Flocks are numbered and named, and each year a report is made to the society of the number of ewes in the flock, rams used, additions, and so on.

CHAPTER 6

The Shropshire

The Shropshire of the present day represents a very different type of sheep than it did a century ago. Although its type has been more or less standardized, there is, as in many other breeds, considerable variation, some of which has its origin in the types of sheep from which the Shropshire was developed, and some of which is due to different standards of breeders. Part of the Shropshire's origin is attributable to two or more strains that were native to the home of the Shropshire, and part is traceable to the Southdown, Leicester, and Cotswold sheep. Some of the variation noticed, such as the occasional speckled face and legs, is probably due to the native strains known as the Morfe Common, Cannock Chase, and Longmynd. The appearance of scurs or horns in rams may also be attributed to this part of the breed's ancestry. Some of the body features were received from the Southdown with which early Shropshires were crossed, and the fact that the Shropshire is one of the heaviest wool producers of the medium-wooled breeds is doubtless due to the influence of the Cotswold and Leicester, both of which were capable of increasing the length and weight of wool produced by the old native stock. Here, too, may be the source of the larger size of the Shropshire compared with the Southdown. The native strains were dark-faced.

Shropshires are alert, stylish sheep that have found general favor for many years with farm sheep raisers in this country. The object in the development of the breed was that of a "rent payer." This meant a sheep of reasonable size and reasonably good meat qualities combined with reasonably good shearing properties. The student need not be surprised, therefore, to find the Shropshire less outstanding than the Southdown in respect to its approach to the ideal meat type in conformation, nor to find that it excels the Southdown in weight of fleece. It has been a distinctly "middle of the road" type representing neither extreme. It has lost some of this



Courtesy University of Illinois

This Shropshire ram has the characteristics of head and body many breeders admire. Farmers usually prefer more size and scale.

popularity because of the introduction of fads, with respect to its distinguishing breed features, which did not enhance its usefulness.

Size. Mature rams vary from about 175 to 250 pounds when in breeding condition. Farm sheep raisers have been more insistent on size in rams than the purebred breeders. Many farmers think rams weighing less than 200 or 225 pounds are too small for the breed if it is to retain its usefulness. Other breeders think that size is of secondary importance if the rams possess other features. Failure to maintain size has caused some commercial producers to choose other breeds. Ewes generally weigh from 135 to 175 pounds. Sheep in high condition will exceed the weights given, and undersized or old, thin animals will fall below the lightest amounts shown.

Form. The form of the Shropshire is rather different from that of the Southdown. The legs are slightly longer, and this is true of most parts of the body. The head is moderately short and broad; the neck is moderately long and slightly arched so that the head is

Courtesy J. L. Edmonds, University of Illinois

Big rugged Shropshire rams of this type are often referred to as "farmers' rams."

carried higher than the level of the back. This contributes to a distinctive style. The ribs are well arched, but the body has more length than is sought by some who desire extreme compactness. It is doubtful if this length represents a criticism, for it contributes to the weight and adds roominess for reproduction, especially in ewes. Shropshires are not thoroughly satisfactory in the fullness of the hindquarters. The quality of flesh is good but not exceptional. The legs are generally well placed but often do not set so wide apart as in the case of the Southdown. The Shropshire generally shows the required ruggedness with respect to size of bone; yet there are specimens that are overly refined. The best specimens are thick, symmetrical, smooth, and possess many of the features of the best mutton type with thick, firm fleshing along the back and other parts.

Wool. Shropshire fleeces are generally dense and of sufficient length to yield good amounts as well as afford ample protection to the animals. Fleeces average from eight to ten pounds after a period

of twelve months' growth. Flocks in which the yolk is abundant will yield fleeces that weigh considerably more than the amounts given. The wool is distinctly of medium fineness, medium length, and medium uniformity. On the market it is generally graded as three-eighths blood, but there are fleeces with sufficient fineness to be graded as half blood, and some are coarser than three-eighths grade. Since the fleece will usually attain a length of at least two and one-half inches or more in a year's time, it is sufficiently long to sell above the price for shorter types. The best fleeces are bright and free of excess yolk and remain in good condition. Occasionally, fleeces may contain black fibers, and sometimes there is a great lack in uniformity shown by the hairiness of wool on the thighs. The wool extends to the pasterns in most young animals, but in some older sheep it reaches only to the knees and hocks. The wool on the lower legs is of little value, even if this feature is often emphasized in breeding. On the head the wool extends over the face so that only the mouth and nostrils are not covered. The wool on legs and head should be white; dark wool is looked upon with much disfavor.

Characteristics. The most distinctive characteristic of the present-day Shropshire is the extreme wool covering over the face and legs. This feature has been sought so strongly and emphasized so much in show specimens that the more useful features of the breed have been neglected. If the individual did not show this extreme covering, it made little difference how excellent it might be in other respects; it received no award. Sheep with so much covering are certain to become wool blind during some part of the year, necessitating the clipping of wool from about the eyes. This task is not relished by farmer or rancher, and many Shropshires were passed by for breeds not thus handicapped. It is difficult to understand why producers of other animals considered blind ones of little value while many Shropshire breeders were trying to develop the condition.

The color of the face, ears, and legs not covered with wool is a deep, soft brown. Although the Shropshire is called a black-faced breed, a black color is extremely undesirable. A reddish or rusty brown is likewise not favored. A dark gray is readily accepted. There is no objection to a small blotch of white hairs near the tip of the face above the nostrils, but the face must not be speckled because of the presence of such patches of white on other areas. This

Courtesy University of Illinois

These Shropshire ewes are in short fleece.

is true also of the ears and legs. The ears may be covered with either hair or wool. Some breeders prefer the "mossy" ear due to short tufts of white wool. The ears must not be heavy or long if the sheep is to be given a high rating in the shows. The ears are carried horizontally, which gives the head the appearance of great width.

Small horns or scurs are often found on rams and are discounted in varying degrees by breeders. Ewes do not have horns. Loose skin, folds, or a dewlap underneath the neck is a criticism. Dark wool in the horn pits, above the eyes, at the base of the ears, on the poll, or on the legs is also a criticism of some importance, as such conditions may be accompanied with dark fibers throughout the main parts of the fleece. The skin is a bright pink. When blue skins are found, the sheep is given a lowered rating. Often, this pigmentation in the skin is accompanied by dark fibers in the fleece. Many otherwise pink skins have bluish spots. Old sheep seldom have the freshness of skin coloring found in lambs.

Utility. Shropshires do not rank with Southdowns in early market maturity, but they probably approach more closely than any other breed to the Southdown. They have good quality of flesh, and the lambs grow at a faster rate than the Southdowns, especially if produced by parents above average in size. Lambs will approximate 85 pounds at six months of age, but many exceed this figure. In live specimens the fleshing does not seem so even as in the case of the Southdown, but in the carcass this quality is generally satisfactory. In fact, some of the best carcasses received on the central

markets are obtained from the Shropshire. Shropshires have been the chief contenders for championships against Southdowns at many shows.

Many years ago some Shropshires were used on the ranges of the West for crossing, but practically none are found in use for that purpose at present. Many Shropshire rams are used on grade flocks on farms, however, and give satisfactory results. In comparative tests lambs from western fine-wool or crossbred ewes and by Shropshire rams have only slightly excelled lambs by Southdown rams in growth rate and have been considerably below in market grade.

Prolificacy is often claimed as an outstanding feature of the Shropshire. Records do indicate the breed rates high in this regard, but it probably is equaled by some others. Flocks will generally show from 125 to 175 lambs per hundred ewes. A lamb crop born is not the same as a lamb crop raised, however. Lambs are generally active at birth and weigh from 7 to 10 pounds. The ewes are good milkers. Occasionally, ewes are found which are exceptionally good milk producers.

In general utility the "utility" type Shropshire ranks high in the opinion of farm sheep raisers. Utility type implies good size and freedom from wool blindness. The rams are moderately active, but many are not fertile early in the fall breeding season. As an early lamb producer, the Shropshire is not outstanding because of this condition. Breeders of purebred Shropshires would do well to keep in mind that the usefulness of and demand for a breed rests upon how well it meets the desires of the commercial lamb raisers and the requirements of the market. While the removal of excess wool from about the face might rob the breed of some of its grandeur and nattiness in the minds of the breeders, it would increase its favor among farmers.

Standard of excellence. A pamphlet published some years ago by the association of breeders contained the following points regarding Shropshire sheep.

Type and general appearance. Alert, attractive, stylish, showing the true characteristics of the Shropshire 30

Form and constitution 30

Head. Set well up with impressive Shropshire characteristics; the head of rams masculine; short, broad nostril and broad between the eyes and ears; the head of ewes fem-

inine, medium length, not delicate. In all cases covered with wool, ears short, erect; eyes bright, full; face brown to clear, dark color, not sooty black.

Neck. Short and muscular and fitting gracefully into shoulders in rams; neck of ewes not so strong as in rams.

Body. Well-proportioned, even shoulders fitting into deep, wide brisket; full neart girth; broad, level back; ribs well sprung; straight underline; loins thick fleshed; flanks deep; low, firm twist and thick leg of mutton.

Legs. Same color as face, short, straight, set well apart; strong, upright pasterns.

Size. Rams, mature breeding condition not less than 175 to 250 pounds; ewes, 140 to 180 pounds.

FLESHING 25

Back, loin, and legs showing large percentage of flesh compared with other parts; emphasis on quality and quantity of flesh, not fat; strong bone in legs conformable with size of body; symmetrical.

FLEECE 15

Elastic to touch, dense, uniform, grading three-eighths and quarter combing; distinct crimp; free from black fiber and hairiness. Scrotum well covered.

The following objections were listed: long, narrow head, long ears, long neck, long legs, crooked spine, light flanks, long, weak pasterns, narrow chest, black wool on head, failure of wool to meet on face and cheeks below the eyes, white spots on bare parts of face and legs, very spotted or dark skin.

Sheep are supposed to be disqualified for registration if they are so lacking in type as to make it doubtful what the breed is. Likewise, horns or stubs (not scurs) and a head quite bare of wool are considered as disqualifying the animals.

At the present time there is some agitation with respect to the requirement for such extreme wool covering on the face, but no action changing the standard has been taken by the breeders' association.

Distribution. The stronghold of the Shropshire in this country is in the Central States. As already stated, few are found in the range country, although there are farm flocks in some western states. There are only occasional flocks in such states as Kentucky and other southern states. There are many flocks in Missouri, Illinois, Indiana, Ohio, and in the states north and east of those

named. Shropshires have been exported from England to some other countries as well as the United States, but apparently in no other section have they become so numerous as in this country. Very few are imported from England at present. This is largely because of the change back, in the native home of the breed, to the earlier type of larger size and less wool on the face.

Registration. The American Shropshire Association was organized in 1884. It has sold shares to more than 10,000 stockholders, and more than 1,000,000 sheep have been recorded. The association formerly published all of the pedigrees of the sheep which it recorded, but this has not been followed during the last quarter of a century and very likely will not be resumed. The names and other information of winners in several of the leading shows during recent years have been published as a booklet or as a part of one of the journals devoted to sheep raising. The headquarters of the society are at LaFayette, Indiana.

The Shropshire breeders in England annually publish a volume which lists the flocks, numbers, owners, and other information pertaining to Shropshire affairs in that country. Much of the early history of the breed is found in early numbers of these volumes.

CHAPTER 7

The Hampshire

Increasing popularity has been the lot of the Hampshire breed during the last half century in the United States. Like many other breeds, the Hampshire was formed not through the use of one strain but by the intermingling of the blood of several in order to develop a sheep with special attributes. Within the district in England where the Hampshire originated were sheep of two strains: one, known as the Wiltshire, was large and coarse, with mutton of mediocre quality and light fleeces; the other, the Berkshire Knot, was similar in general features. Apparently, the rams of both had horns. The former had white faces, and the other was black on the face and legs. From this foundation and through the use of Southdowns and, to a much lesser extent, Cotswolds, breeders created the Hampshire. It now ranks among the leading breeds of medium-wooled sheep in this country.

Hampshires have retained some of the features of the early type, but they now show more refinement and greater symmetry. In attaining these improvements breeders have not sacrificed size, although in some areas very lowset, compact sheep are now desired, with lessened emphasis on size. Several other attributes have also been retained. Among these are rapid growth and aggressive feeding habits of the lambs and heavy milk yields of the ewes. None of the strains used extensively in the development of the Hampshire was a heavy wool producer. The general appearance of the breed is of a strongly constructed, massive, muscular sheep with a long, deep body and impressive head features.

Size. The Hampshire is one of the largest of the medium-wool breeds. There are individuals of the Suffolk and Oxford that are larger than some Hampshires, and it is probable that the Oxfords as a group are a little heavier. Hampshire rams in mature breeding condition may weigh from 225 to 300 pounds. Ewes generally range from 150 to 200 pounds. In both sexes there are many

Courtesy A. W. Bagley, Salem, Oregon

Two views of a Hampshire ram show the head features, form, size, and sturdiness desired.

individuals of lesser weights, especially when in relatively thin condition. In western flocks size is emphasized more than in flocks kept in the Central States. In show specimens, size has sometimes been sacrificed to favor smoothness and other features of form.

Form. The general shape of the Hampshire is broad, deep, reasonably compact, and lowset. The framework is, in general, consistent with mutton type, but in the detail of parts many Hampshires show defects. The head is often described as having a Roman profile. This is true of some rams, but it is not true of all. Few ewes show distinctly rounding profile of the face. The head is large like the rest of the skeletal makeup and is usually carried high, as there is a medium or greater length of neck. The neck vein in the best individuals is full and smooth, but many show only fair smoothness in this region. The shoulders are broad and sometimes heavy, but more refinement is being sought in this part of the body, and much improvement has been effected during the last quarter century. The region back of the shoulders is sometimes deficient in arch of rib, and this, together with the broad shoulders, may give an impression of a lack of smoothness. Most Hampshires now do not show this "devil's grip," and the body is generally smooth with good muscling along the back. The "touch or handling quality" along the back is not so smooth as in the smaller breeds. This may be due to the larger vertebrae of the Hampshire and not to lack of flesh. The loin is broad, and the hindquarters are large; but many individuals do not have the full, plump, deep leg and twist that are desired. Some are extremely well developed in these parts, and there is probably within the breed the means of further improvement. Breeders generally place great stress on strong bone and sturdy legs. As in other breeds, some Hampshires are weak in the pasterns. This is a serious defect when, as under range conditions, much travelling is required.

The Wyoming Experiment Station[1] made body measurements of prize-winning Hampshires at the International Live Stock Exposition during a five-year period. The study was directed toward answering what points receive greatest emphasis in the show ring and what constitutes a typical Hampshire carcass and fleece. While the study indicated that show-ring judging was as much an art as a science and that the mechanical measurements cannot be substituted for the delicate balancing of points which judges at-

[1] Wyo. Agr. Exp. Sta. Bul. 207. 1935.

tempt, some of the measurements were of significance; and it is possible that with greater diversity among the winning animals, the measurements might have been of even larger moment in showing what constitutes a typical Hampshire. In the final placings among a group of animals already carefully selected and highly fitted, certain intangible characteristics receive much emphasis. Such things as style, masculinity, femininity, straightness of legs and pasterns, handling qualities, and breed character all received attention in the ratings, but were unmeasured in this work.

On the basis of measurements of yearling rams (no reference is made herein to measurements of ram lambs, yearling ewes, and ewe lambs) an acceptable height from the ground to the withers would be 2.3 feet, and the distance from the floor of the chest to the ground, which is the same as length of foreleg, would be 1.1 feet. Thus, the depth of chest would be slightly greater than the length of leg so that more than 50 per cent of the total height would come from depth of body. The measurements show the length of hindleg to be slightly greater than the length of foreleg, whether measured as distance from the ground to the flank or to the deepest part of the twist. The ground to twist measurement was approximately 1.4 feet. Body length, like some of the other measurements, is difficult to determine, but the report shows the Hampshire to have a good length of body measured from neck to dock. The twenty-five winning rams averaged approximately 2.5 feet in this dimension. Some measurements, like the impressions gained by observation, are greatly influenced by the amount of fat carried by the animals. Chest, body, and rump width and heart girth are some examples of parts whose measurements are so influenced, and these measurements show considerable range. However, the Hampshire rams in this study showed an average chest width of slightly more than one foot and an average heart girth of 3.8 feet. The heavy bone of the Hampshire is indicated by the size of the shin bone, which, in the twenty-five rams measured midway between the ankle and knee, showed an average measurement of 0.4 foot or almost 5.0 inches. This is not actual bone measure as it includes the skin and hair covering.

Wool. The shoulder wool samples from these rams showed an average fiber diameter of 0.001 inch. There were 8.1 crimps per inch of fiber length, and the average number of fibers per inch of skin area was 9,218. Wool is not a major consideration in the se-

lection of Hampshires after it reaches a certain minimum requirement, and there are factors other than those shown which are of equal, or, in some aspects, of more importance with respect to wool than the measurements given.

In general, Hampshires are not a heavy-fleeced breed. The fleeces of mature breeding sheep usually weigh from seven to eight pounds, but there are many outside this range. In twelve months the wool attains a length of two or two and one-half inches. The wool is usually a little coarser than that of the Shropshire. It is usually not very high in grease except in the case of some lambs and, thus, is relatively light in shrinkage. While the fleece, to be of good quality, should consist of only white fibers, the fleeces of many mature Hampshires have black fibers scattered among the white ones. Breeders guard against the condition becoming worse by selecting for stud purposes rams which are, in general, free of black fibers. It is doubtful if the condition will ever be eliminated from the breed so long as animals with very dark markings are preferred.

The wool extends to the ankles in many lambs, but many older sheep do not show wool below the knees and little below the hocks. Breeders seek white wool on the legs and over the head, but there are many specimens that have brown or black wool on the legs and dark spots above the eyes and about the region of the horn pits. Recently, some breeders have favored Hampshires with woolly faces. Some show specimens were almost as completely covered as were Shropshires. The Hampshire breeders in the western areas, however, feared that the breed was being harmed by this fad and contended for a sheep in which there was no danger of wool blindness. The Hampshire Association has adopted a recommendation that the wool need not extend beyond a line even with the eyes. While some breeders report they favor greater covering of wool on the face, it is apparent that breeders should give attention to features that add to, rather than detract from, usefulness.

The fleeces of Hampshires are sometimes very short on the underline. This reduces fleece weights. Some fleeces have a harsh or wiry touch. Little attention has been given to the cause of this harshness. Fleeces that are greatly lacking in uniformity, as shown by long coarse fibers on the thighs, are very undesirable.

Characteristics. The Hampshire is an impressive breed. Much of its attractiveness comes from the color of its face and ears. The color is usually described as a rich, deep brown approaching

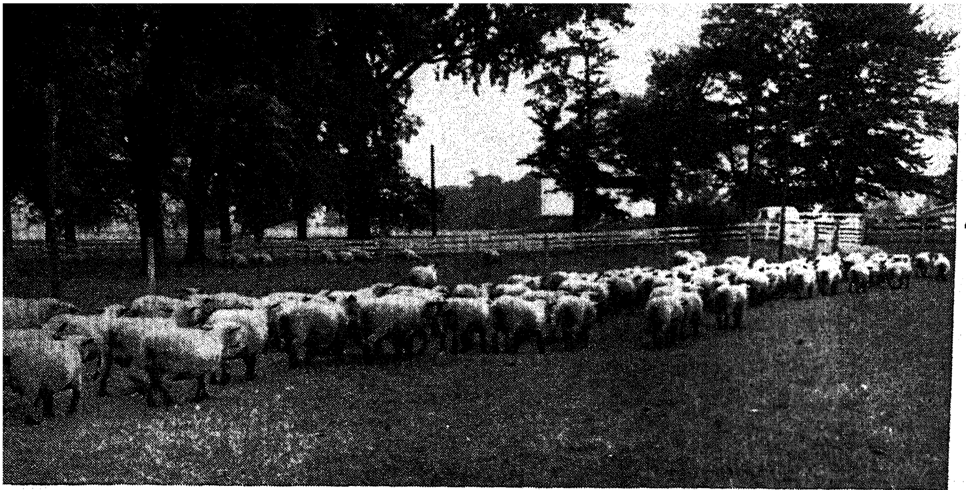
black, but to most observers the color is simply black. This color makes a striking contrast with the white wool of the head and body. The desire for this contrast is one of the reasons for objecting to black wool about the eyes. Another objection is based on the likelihood that black in that region may be accompanied by black fibers in the main part of the fleece. The hair on the legs is the same color as that on the face. Breeders dislike a reddish tinge, and speckled faces are not tolerated, although a splotch of gray near the tip of the nose is acceptable to practically all and desired by some breeders.

Hampshires have large ears, but the ears must not be coarse and heavy. The ears may be coarse in comparison with those of some other breed, but they must not appear coarse on a Hampshire where they are merely in proper proportion with the other features. It seems that most breeders prefer ears free of wool; some like short tufts of white wool on them. Light-colored ears are disliked in western areas. The ears are rather long and carried horizontally or at a slight droop. Any tendency toward an upright carriage is disliked.

Hampshire ewes are hornless, and most rams are also hornless. There are numbers of rams that have scurs, which are not greatly disliked by many breeders if the rams are otherwise good individuals. If the growths are solid and can be seen rather than only felt when the sheep is in full fleece, much objection is made to them.

Because dark-colored skins may be found associated with black fibers in the fleeces, pink skins are desired. Few mature Hampshires have the fresh pink skins often seen on lambs.

Utility. One of the features for which the Hampshire is renowned is its rate of growth. As a breed it is doubtful if there is in this country any other which surpasses it; and there are few, if any, that are its equal in this respect. When lambs are liberally fed they make phenomenal gains in weight, often exceeding a pound a day increase. They thus attain what seem to be preposterous weights before they are a year old. Lambs shown at the International Live Stock Exposition have weighed as much as 240 pounds. Thus the breed is adapted to regions of abundant feed so that its qualities for growth may be fully developed. It is not, however, a breed which is dependent upon heavy-grain feeding for nutritious pastures, and the milk of the ewes will produce good growth in lambs. It is possible that this rapid growth is accompanied with some re-



Courtesy L. T. Dwyer, Franklin, Indiana

This flock of ewes shows the meat-producing qualities of the Hampshire.

duction in longevity. The desire of the lamb feeder for black-faced feeder lambs and his willingness to pay a premium for them is testimony of the way the Hampshire lamb responds to feeding. These lambs are not, in the majority of cases, of only Hampshire breeding, but they do show the black face because most of them are sired by Hampshire rams. Feeders think they have a greater capacity for heavy feeding and ability to make gains because of their Hampshire parentage.

In quality of meat the Hampshire ranks high. Part of this may be due to its Southdown inheritance many years ago. The lambs dress a good percentage—many loads of grade Hampshire fed lambs exceeding 50 per cent. The percentage of bone in the carcass, as indicated in an Illinois study,[1] may be higher than in the Southdown, but the difference is probably much less than usually anticipated. The percentages reported were 13.05 for Southdowns and 16.33 for Hampshires. There is a good relationship between fat and lean, and the meat is fine grained and firm. The carcasses are not often finished at such light weights as are those of the Southdown.

Hampshire rams are probably used to a greater extent for crossing in the United States than are the rams of any other breed. There is no state in the great western sheep areas where the Hampshire is not used to cross with either fine-wool or crossbred types of ewes. Hundreds of thousands of such grade Hampshire lambs grow and fatten for market on the mountain ranges without ever

[1] Branaman, Geo. A. Some factors in lamb production associated with size and type in mutton sheep. Jour. Agr. Res. Vol. 60. No. 7. 1940.

having received grain. These lambs are superior to lambs from rams of the same strains or breeds as the ewes. Many grade Hampshire ewes are now bought as yearlings for use by Kentucky lamb raisers. There the ewes are bred to Southdown rams. The ewes have the large bodies and heavy yields of milk needed to make the lambs fat and plump at light weights.

Prolificacy is strong in Hampshires. Whether they excel some other breeds is doubtful, but they do perform well with respect to the number of lambs dropped. The ewes have strong maternal instincts, and most of them are good milkers. An owner of a flock of several thousand ewes has reported raising a lamb crop of over 135 per cent, and many small flocks have raised from 175 to 200 per cent lamb crops. The lambs are large at birth, averaging about 10 pounds, but there are many that weigh several pounds more than that. Ease of parturition is not one of the features of the Hampshires. Many ewes must be assisted in delivering their lambs. This difficulty seems to arise mainly because of the size or shape of the shoulders of the lambs.

Standard of excellence. Some years ago Hampshire breeders adopted the following description for their sheep. Such descriptions are useful guides but are subject to differences in interpretation and thus do not hold the breed to an inflexible standard.

Head. Face and ears of a rich, dark brown approaching black; dense wool covering over poll and forehead; large, bright, full eyes; ears medium in length; medium in thickness; edge of ear slightly curved, projecting slightly forward and downward. In rams, a bold, masculine head. In ewes, a refined, feminine head.

Body. Deep, symmetrical, and thickly fleshed, with wide spring of ribs; broad, straight back; level loin; wide rump; full dock; deep and heavily developed legs of mutton and breast.

Legs and feet. Legs short, strong in joints and powerful, set well apart, hocks and knees not bending toward each other. Pasterns strong, feet sound.

Wool. White, of medium length, compact, and medium fine in texture. Scrotum of rams well covered with wool.

Skin. Preferably pink in color.

Objections listed for sheep of the Hampshire breed include: prominent scurs; white specks on face, ears, or legs; black wool; excessive coarseness; and loose skin under the neck.

Distribution. The Hampshire is probably as widely distrib-

uted in this country as any breed. There are many large flocks in the range states. Missouri and Illinois were two of the leading states in numbers registered during 1945. There are also many eastern flocks. The Hampshire has experienced great popularity despite the criticisms leveled against it. This is because it has met the rangeman's and the farmer's idea of a profitable sheep with respect to size and growthiness, coupled with an ability to utilize roughage of comparatively low grade.

Hampshires have been exported from England to many countries, but it seems that in no other section have they become so widely distributed as in the United States. Some importations are still made, but increasing reliance is being placed on stock raised domestically; the word imported does not fascinate as in earlier times.

Registration. The American Hampshire Breeders' Association was founded in 1889. It has been an aggressive organization in the promotion of the breed. It is the only association which has kept up to date the publication of its flock book listing all registrations and transfers of sheep. Registrations exceeded 34,000 during 1945, and the total of registrations now surpasses 600,000.

In England the association of breeders also publishes an annual volume with information of interest to flock owners.

CHAPTER 8

The Suffolk

Although the Suffolk has been known for many years in England, it did not become one of the prominent breeds in the United States until recent years. At the present time it is as capable of arresting the attention of the lamb raiser as is any other breed. It is a medium-wool type which in its native home in Suffolk and surrounding counties in England has long had a reputation for the superior quality of its meat. The Suffolk is an alert, active sheep developed through the use of large-type, dark-faced Southdown rams on an old strain known as the Norfolk. These were described as wild, hardy, active, upstanding, black-faced, horned, light-fleeced, and of faulty conformation but with superior texture and quality of meat. They were also said to be highly prolific. The Southdown was used for the purpose of removing the horns and to improve fattening tendencies and body form. Apparently these things were accomplished without the loss of many of the attributes possessed by the foundation sheep, for the present-day Suffolk still has many of the original traits.

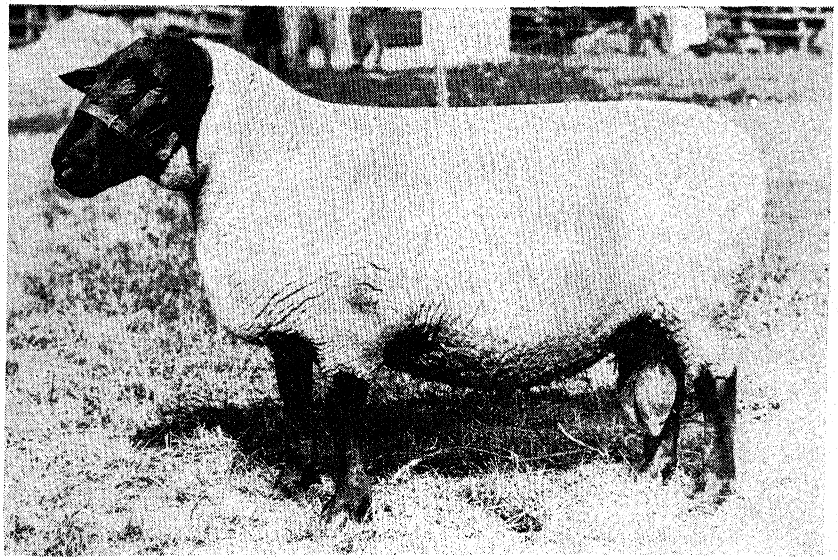
Size. Suffolks are very close to the Hampshire in weight. Size has been emphasized by the man of the western range, the area where the breed first gained a foothold in this country. Mature rams weigh from 225 to 300 pounds when in good breeding flesh. Ewes weigh from about 160 to 225 pounds. Many Suffolks weigh more than would be estimated from their appearance as they have comparatively short wool and they are very muscular.

Form. The Suffolk is usually referred to as an upstanding sheep, but this should not be taken as meaning that it is characterized by unusually long legs. The upstanding appearance is emphasized by the lack of wool on the underline of many mature sheep. The general shape of the body is such as to place the Suffolk among the best of the mutton-type breeds. There are, however, defects in conformation when the Suffolk is compared with the Southdown,

if the latter is taken as the standard. The body may be lacking in smoothness, and the neck is often rather long. The back and loin have good width, the body is deep, the hindquarters are well proportioned, and the development of the leg is exceptional. The muscling along the back is heavy and firm, and the fat covering is smooth. In heart girth the Suffolk is not outstanding as too many of them lack fullness in arch of rib. The shoulders are refined, and Suffolks are said to have little difficulty at lambing time. The legs are generally straight and strong. The legs being free of wool, the breed does not have the appearance of ruggedness and heavy bone characteristic of the Hampshire.

Wool. The light fleece is one of the Suffolk's chief deficiencies. It is likely that the average weight of wool produced in a year's time does not exceed six or seven pounds. The fleeces of old ewes are extremely light, often weighing only four or five pounds. The light weight is due to the lack of covering on the underline and a rather short staple—from 2 to 2½ inches—on the rest of the body. The wool is usually of low shrinkage. It is about the same fineness (three-eighths blood) as the wool of the Hampshire. Fleeces are only of medium density. Black fibers are often found in Suffolk fleeces. This is to be expected in any breed that has such black faces and legs. Breeders are trying to reduce the occurrence of black fibers, but it is doubtful if the fault will be completely eliminated. Some efforts are being made to increase the growth of wool on the underline both as a means of increasing fleece weight and as a means of greater protection during cold weather. The Suffolk stands cold well, however, and may withstand heat considerably better than some other breeds of medium-wool type.

Characteristics. The Suffolk commands immediate attention because of its distinctive markings, the proud, high carriage of its head, and by its activity. The head, ears, and legs are black. Any tendency to a brownish cast is very undesirable. The head and ears are entirely free of wool to a line back of the base of the ears. In some cases there is a small tuft of clean, white wool on the poll and high on the forehead. While this is not objectionable, more than this minimum amount is not desirable. The legs below the knees and hocks are covered with fine, black hair. It is said that the scrotum of rams should be covered with wool, but this is not often the case, nor is the reason clear.



Courtesy University of Idaho

This Suffolk ram is of superior breed type and body.

The ears are long and pointed and are generally carried at a very slight droop or horizontally. The ears show more refinement than those of the Hampshire. The same relationship exists with respect to other features of the head. Because the Suffolk is able to see clearly, its movements are quick, and it becomes instantly alert.

Both rams and ewes are hornless, although, like some other breeds, rams may have scurs. The skins of lambs may be pink, but most older sheep have dark-colored skins.

Utility. Either purebred or grade Suffolks have the capacity for rapid growth. At birth the lambs are large and active, and with the abundant milk of their mothers they make fast gains. The Suffolk lambs do not attain the early plumpness of the Southdown and seem to develop framework during the first stages of growth with a tendency to fatten later. There are many instances where Suffolk lambs, both grade and purebred, have shown weights equal to, and in some cases above, those of Hampshires.

As a grazer the Suffolk is among the best because of its activity and rustling qualities. The Suffolk is unsurpassed in traveling in search of food. It is not as easily herded as some breeds because of

its activity and lack of close-herding instinct. Lambs are active feeders and come to market fat if on good range or pasture. Feeder buyers have been well pleased with the response of lambs on finishing rations.

Suffolk carcasses lack the compactness of some other breeds, but the dressing percentage is high; and there is usually a desirable intermingling of fat and lean. Few Suffolks have been shown in this country in live or carcass competition, but in England the breed has been especially successful in the great Smithfield shows, where it has been the chief competitor of the Southdown. Many butchers in England express a preference for Suffolk carcasses because of the high percentage of weight in the region of the back and hindquarters, the thickness of muscling, and the marbling of lean meat, with little tendency to excessive external fat.

The Suffolk is becoming increasingly esteemed for crossing. Its small head and shoulders make it relatively well suited for mating with small ewes without risk of difficulty and of heavy losses at lambing. Lambs from a Suffolk ram and a white-faced ewe will sometimes have speckled faces. In a report of an experiment in Canada, crossbred Suffolk lambs were more profitable than were the lambs of seven other crosses, as the former combined weight, quality, and feeding ability to the highest degree.

Suffolk ewes are very prolific. Whether they are superior to other breeds in this respect is doubtful, however, as there is much variation from flock to flock and within the same flock from year to year. Few breeds are likely to prove outstandingly superior to the Suffolk in this respect. In milking abilities Suffolk ewes are equaled by those of few other breeds. This attribute is fully attested by the great weights of lambs at weaning.

Standard of excellence. As a guide in selection the American Suffolk Sheep Society has issued the following scale of points.

Head. Hornless, face black and long. Muzzle moderately fine. Ears medium to long in length, black, and fine texture. Eyes bright and full. A small quantity of clean, white wool on the forehead not objected to	20
Neck. Moderate length and well set	5
Shoulders. Broad, smooth, well covered with meat	5
Chest. Deep and wide	5
Back and loin. Long, level, and well covered with meat. Tail broad and well set up. Ribs long and well sprung. Full flank	25

Twist. Well filled	10
Legs and feet. Straight and black, with flat bone of good quality. Wool to knees and hocks, clean below. Forelegs set well apart	15
Belly. Covered with wool	5
Fleece. Moderately short, dense, fine fiber without tendency to mat or felt, and well defined; that is, not shading off into dark wool or hair	5
Skin. Fine, soft, pink color	5
Total	100

Distribution. Suffolks are increasing in popularity in the United States, and with it they are gaining in distribution. There are flocks in most of the western states, and within the last ten years there have been many flocks founded in the Corn Belt and eastern areas. Although the breed was first brought to the United States in 1888, it made little progress except during the last twenty-five years. Its progress has been somewhat erratic, but it seems now to have established a field of usefulness. Its proponents are characterized by great enthusiasm, which is offset by an equally strong dislike by its opponents.

Registration. Two organizations for the registration and promotion of the breed have been formed in this country. This is unfortunate, as the effectiveness of one organization would be much greater. The American Suffolk Sheep Society organized in 1929 has its headquarters at Moscow, Idaho. The National Suffolk Sheep Association has offices at Middleville, Michigan.

CHAPTER 9

The Oxford

The Oxford breed was evolved from a more or less heterogeneous foundation through the use of Cotswolds and Hampshires. These two breeds are very different in practically all features, and the Oxford has reflected much of this diversity even up to the present time. At the time the Oxford was established, the breeds from which it was developed were considerably different than at present. Efforts to effect combinations of this kind are likely to fail to create satisfactory uniformity, especially when the breeders engaged in the undertaking have different standards as to the kind of sheep that is to be developed. Throughout much of the history of the Oxford this condition has existed. While the Oxford is widely distributed in the United States, its distribution is more or less localized in communities rather than being on a generalized basis.

Size. The size of the Oxford has been one of its strongest points of appeal for most growers, and it is likely it would now be far more numerous if all its other features were equally satisfactory. It is not unusual for rams when in reasonably good condition to weigh 250 to 350 pounds. Ewes weigh from 175 to 250 pounds or more at maturity when good feeding prevails. This actual size is made more impressive by the relatively long fleece of the Oxford.

Form. The typical Oxford is a large, somewhat upstanding sheep. It is strong and massive and is rectangularly built. It does not show the roundness of form of the Southdown or some other breeds. Since the Oxford is a large breed, it does not show the compactness of form often found in smaller animals. Efforts have been made to develop the breed into a lower set, more compact type, but there is as yet no widespread uniformity in this respect. The ribs are generally well sprung, and the body is wide and deep. The legs are strong, but the Oxford does not show the heavy bone generally found in the Hampshire. Some of this apparent difference is undoubtedly due to the amount of hair and wool on the legs, and the

difference in amount of actual bone between the two breeds may be less than commonly supposed.

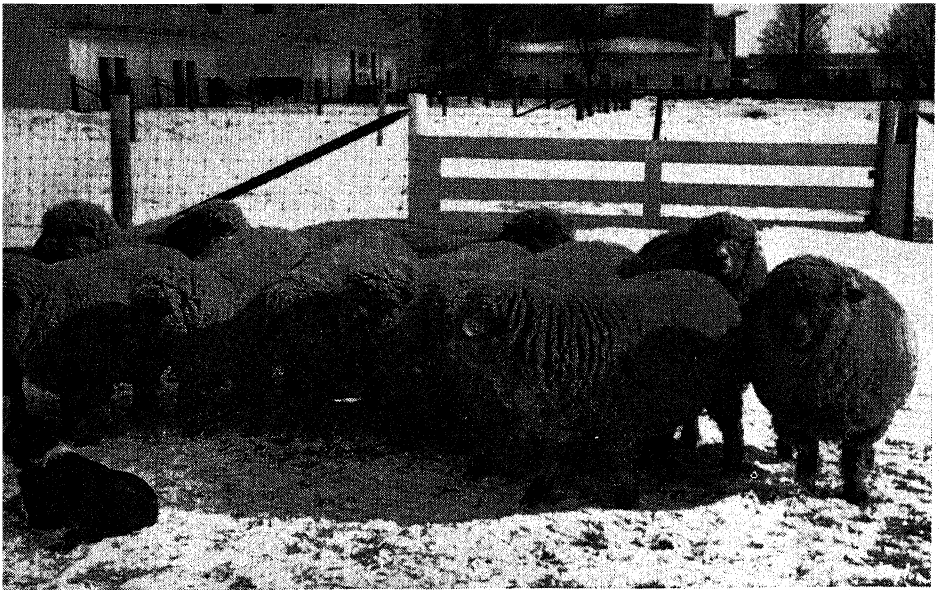
The Oxford carries its head fairly high, as the neck is long like the other parts of the body. The head is not overly large but is in keeping with the rest of the body. The breast is generally broad, and the brisket is fairly prominent. The hindquarters are squarely made, and the best specimens have well-filled legs and twist. Those sheep that appear long legged do not now find favor with most breeders. Legs are sometimes crooked, and weak pasterns are also seen.

The fleshing qualities of the Oxford, as measured by the "handle" along the back, are only fair. Mature sheep may "handle" very well, but many lambs are often criticized for bare backs and loins.

Wool. Oxfords generally shear more wool than any of the other medium-wool breeds. This is very likely due to the use of the Cotswold. The fleece is longer and usually more open than that of the other medium-wool breeds, but there are some individuals that have rather short, dense fleeces. The wool may vary from about 3 inches to more than 5 inches in length during a twelve-month period. Fleeces show some range in diameter of fiber also, but the most frequent grade is quarter blood or low quarter. In carelessly bred flocks the grade may be lower, and the general lack of uniformity of fleeces is readily noticeable. Most fleeces weigh from 10 to 12 pounds, but it is not unusual for some to weigh 15 pounds.

The wool extends over the head and face, but, with few exceptions, the Oxford breeders have avoided so great an extension as would cause a wool-blind condition. Frequent mention is made of the top-knot or tuft of wool on the forehead that may be longer than the rest of the wool on the head. Few Oxfords show this naturally, and most of the effect is through the use of shears for trimming when fitting for show. Sometimes Oxfords are shorn without this tuft being removed. On the legs the wool extends to the knees and hocks in all cases and to the ankles in many. Black fibers occur, but in most cases they are found in those individuals that have darker features than most breeders desire.

Characteristics. The color of the face, ears, and legs preferred by most breeders is a dark gray or brown. There is no objection to a light gray region about the nose. In some specimens the face may be extremely light gray, while in others the color may be so dark



Courtesy American Oxford Down Association

The variations in color of face and extension of wool shown by this choice lot of Oxford ewes are typical of the breed.

as to approach the color of the Hampshire. Often, the latter color is accompanied by dark wool about the eyes and on parts of the forehead and on the legs below the knees and hocks.

The ears are of medium size and are carried horizontally. Frequently, the ears are covered with small tufts of wool. Rams are sometimes found that have scurs or small horns. These are considered as detracting from the merit of the rams. The face is of moderate length. The Oxford has a fair degree of style as the head is carried reasonably high. Breeders desire sheep with pink skins, but many show a light to dark blue tinge.

Utility. Oxfords produce large lambs, and they are generally regarded as being among the more prolific breeds. Lambs will weigh 9.5 to 10.0 pounds at birth as an average, but lambs of almost twice these weights are not infrequent. Rapid growth is also characteristic of the lambs as the ewes are good milkers. Few lambs fatten as they develop, and many of them have been severely criticized for being overweight and lacking finish when marketed. Extra good feeding is a requisite for fattening of the lambs. The quality of the carcasses is only fair, as there is no strong tendency for an intermingling of fat and lean. Too much external fat and some lack of fineness of texture of lean are sometimes given as criticisms.

The usefulness of the breed for crossing is sometimes stressed, but the Oxford has failed to establish itself on the ranges to any degree comparable with the Hampshire or Suffolk. Tests have been conducted in which the breed has not made a notable record when rams were bred to fine-wool ewes for the production of market lambs. In lamb-production contests in Michigan and Minnesota where the basis is the pounds of lamb produced per ewe in a limited period—usually about four and one-half months, the Oxfords have done well.

Scale of points. The following is adapted from a standard published by the Oxford Breeders' Association for the selection of Oxford sheep.

BREED TYPE	
Form. Good general appearance, well-balanced conformation, free from coarseness, showing style at rest and in motion	15
Head. Moderate in length and width, well covered with wool over poll and to the eyes, face even dark gray or brown with or without gray spot on tip of nose	6
Weight. Mature rams in good condition 250 to 350 pounds, ewes 180 to 275 pounds	5
Ears. Medium size and thickness, even brown or gray color	2
Legs. Short, strong, dark gray or brown color, placed squarely under body and well apart	2
CONSTITUTION	
Heart girth and chest. Large, wide, and full	10
Movement. Bold and vigorous	5
Eyes. Bold, prominent, bright	4
Skin. Bright pink	3
Neck. Strong and muscular in rams, well set in both sexes	3
FORM AND QUALITY	
Shoulders, back, loin, and rump. Wide and straight	15
Legs and thighs. Well meated inside and outside	5
Flanks and side lines. Well filled and strong to make body straight and full	4
Carcass. Evenly covered with well-marbled meat	6
WOOL	
Fleece. Moderate length, close, and of even quality, covering the whole carcass, free from black patches on body, neck, or head	15
Total	100

Distribution. Oxfords have been introduced into many countries from England. In no country have they become the dominant breed. They are not adapted to scant pasturage as they are slower in movement than some of the other breeds. While they may thrive under a considerable range of climatic conditions, they do not seem to have any special adaptation not possessed by other breeds. There are flocks in many of the states, but most are found in the Central States and eastern Canada.

Registration. Oxford sheep are registered in the records of the American Oxford Down Record Association, which was organized in 1884. Its headquarters are now at Clayton, Indiana. Up to the close of 1945 the association had recorded nearly 185,000 sheep. Some volumes of pedigrees have been published, but this activity has been suspended for a long period. In Canada, Oxfords, like all other breeds, are recorded in the Canadian National Livestock Records.

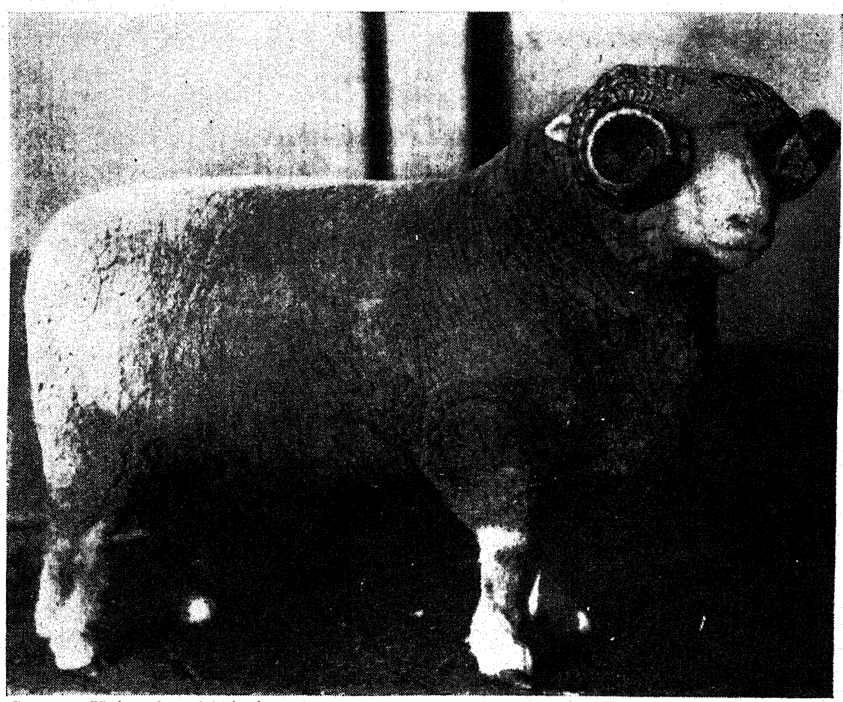
CHAPTER 10

The Dorset

For many years the Dorset has been developed largely through selection, as there is little or no evidence that crossing with other breeds has been of any consequence. That crossing was little used is attested by the fact that the breed is different from the others which were available for crossing. The breed is distinct among all medium-wool breeds ever introduced into the United States in that both the rams and ewes are horned. Further, the Dorset is the only white-faced breed from southern England that has gained any degree of prominence outside its own country. Regardless of its origin, efforts toward improvement have been successful to some extent, at least, and while this improvement has been brought about, some important utility features of the old stock have been retained. The early history becomes of decreasing importance as the breed progresses and as the dates of such history become more remote.

Size. Dorsets are of medium size. They are hardly as big as Hampshires and yet are larger than Southdowns and many Shropshires. Mature rams in good condition weigh from 175 to 250 pounds and ewes from 125 to 175 pounds.

Form. The form of the Dorset can be described as one of medium characteristics. The body is moderately lowset, moderately compact, and of a medium degree of smoothness and quality. The bone and head features suggest ruggedness rather than refinement. While the body conforms in general to what would be considered good mutton type, in the detail of parts some criticisms may be made. The back is generally strong, but some Dorsets are high at the top of the shoulders and lack evenness and fullness back of the shoulders. The breed is generally deep bodied and there is reasonable fullness of hindquarters, although drooping, narrow rumps were fairly common at an earlier date. A moderate degree of style is evident. Backs and loins have a fairly good amount of fleshing,

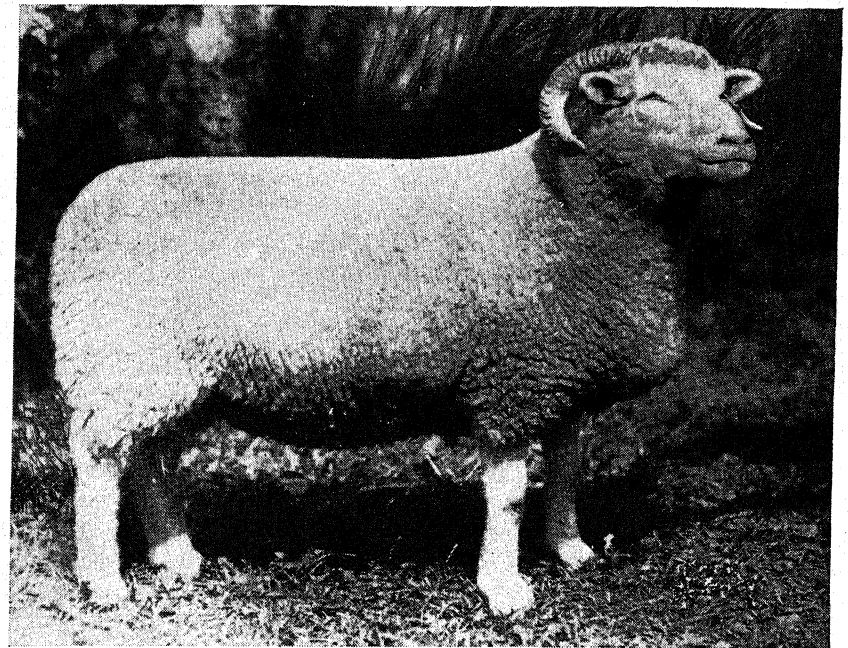


Courtesy University of Illinois

This Dorset ram has the horns, color of face, and covering of wool which are typical features of the breed.

but few Dorsets are rated as having exceptional merit in this respect. The legs are generally well set and strong, although weak pasterns are by no means absent in the breed. Rangy, rough-made individuals are considered undesirable, and there has been considerable emphasis on greater refinement and smoothness.

Wool. The wool extends over the forehead where there is a small tuft. There is no wool on the face, although it extends onto the cheeks. The legs are generally free of wool below the knees and hocks, but in some cases there may be a small amount of wool on the lower parts of the legs. Many Dorsets have very little wool on the underline; in fact, bare bellies are not uncommon. The fleeces are lighter in weight than those produced by Shropshires but are about the equal of the fleeces of Hampshires. An average of about seven pounds would be considered a satisfactory fleece yield in most flocks. The light weight is due to the lack of covering on some main



Courtesy University of Illinois

And this Dorset ewe has the horns, color of face, and covering of wool which are typical features of the breed.

parts of the body, only a fair degree of density, and to the fact that the fleeces are generally light in yolk. The wool attains a length of 3 to 4 inches in a year. The most common grades are three-eighths blood and quarter blood. Dorsets sometimes show considerable lack of uniformity of fineness, and kemp and medullated fibers have not been eliminated, but black fibers are seldom if ever found.

Characteristics. The horns of the Dorset comprise its most unusual feature. The horns of rams are very large and angular and curve downward and forward making a large spiral. Occasionally the horns of rams grow so close to the sides of the head that it is necessary to remove the inner part of the horn to prevent injury. Ewes have much smaller, flatter horns, and these curve downward and forward but do not form a spiral as in the case of rams. Sometimes the tips of the horns of ewes must be removed as they may grow into the eyes or the cheeks.

The face, ears, and legs of the Dorset are white. The nostrils,

lips, and skin are pink. The hoofs are white. Since there is little or no pigmentation in the Dorset, the absence of black fibers in the fleece is not surprising. Style is not outstanding in Dorsets as the head is carried on a line about level with the back. Some rams have considerable arch to the neck and a proud appearance.

Utility. In spite of several unusual features, the Dorset has failed to gain widespread popularity in the United States. The ewes will breed at seasons when most other medium-wooled breeds will not do so. It is not unusual for Dorset lambs to be born in the fall months, and there are many statements to the effect that the ewes will produce two lamb crops a year. This is seldom the case, however, although it is not difficult to have them produce three lamb crops during a two-year period. In some sections of the country, ewes of fine-wool breeding have as great a tendency to produce "out of season" lambs as have Dorset ewes.

Heavy milk production is another feature of the Dorset. Apparently these sheep were once used for dairy purposes, and the milk-producing qualities are found in practically all Dorset ewes. In fact, there are Dorset flocks on the European continent at the present time where milk production is emphasized to as great or to a greater extent than lamb production. Since the ewes are good milkers, they seldom fail to own their lambs, and the lambs grow fast. Because of these two characteristics, many grade Dorset ewes are used where "hot house" lambs are raised. The ewes are among the most prolific.

The carcass of the Dorset is not outstanding. The lambs may be fat at weaning time, but the carcass has no special merit not found in others. Dorset lambs have not gained a strong reputation as feeders after weaning. The dressing percentage is not above average.

Dorsets are not adapted to scant pasturage or feed. They are similar to Hampshires in their need for good care and feeding. Most Dorsets are found in the sections where there is some interest in specialty products such as "hot house" lambs and where grain feeding or the use of forage crops as pastures is practiced. The breed is generally as hardy as most others. When used for crossing, some of the features of the Dorset may predominate in the crossbreds. Many Dorset-Merino ewes are produced, as the milking qualities of the Dorset and the fleece qualities of the Merinos are combined to a useful degree in the crossbreds.

Scale of points. A booklet of the Continental Dorset Club contains the following scale of points.

Head. Neat, face white, nostrils large, well covered on crown and under jaws with wool	5
Horns. Ewe: Small and gracefully curved forward and downward, close to jaws. Ram: Heavy, spiral like, curving downward and forward	5
Eyes. Prominent and bright	2
Ears. Medium size, covered with short, white hair	2
Neck. Short, symmetrical, strongly set on shoulders, gradually tapering to junction of head	5
Shoulders. Broad and full, joining neck forward and chine backward with no depression at either.	15
Brisket. Wide and full, forward, chest full, also deep	8
Fore flank. Quite full, showing little depression behind shoulder	8
Back and loin. Wide and straight, from which ribs should spring with a fine, circular arch	10
Quarters. Wide and full, with mutton extending down to hocks	10
Belly. Straight on under line	3
Fleece. Medium grade, of even quality presenting a smooth surface and extending over belly and well down on legs.	12
General conformation. Of the mutton type, body moderately long; short, stout legs, placed squarely under body, skin pink, appearing attractive	15
Total	100

Distribution. Dorsets have been introduced into many of the states in this country, but most are found in the eastern sections. Efforts have been made to promote the breed on the ranges, but there are few Dorset flocks in the region, and few sheep show any influence of the breed. There are a few flocks in eastern and in extreme western Canada. Dorsets have attained a fair degree of popularity in some parts of the Southern Hemisphere. Few flocks are found in England outside the native home of the breed.

Registration. The Continental Dorset Club, with headquarters in Hickory, Pennsylvania, records Dorset sheep in this country. At one time there was disunity among breeders, but now the club is the only organization promoting the breed. Approximately 75,000 sheep have been recorded.

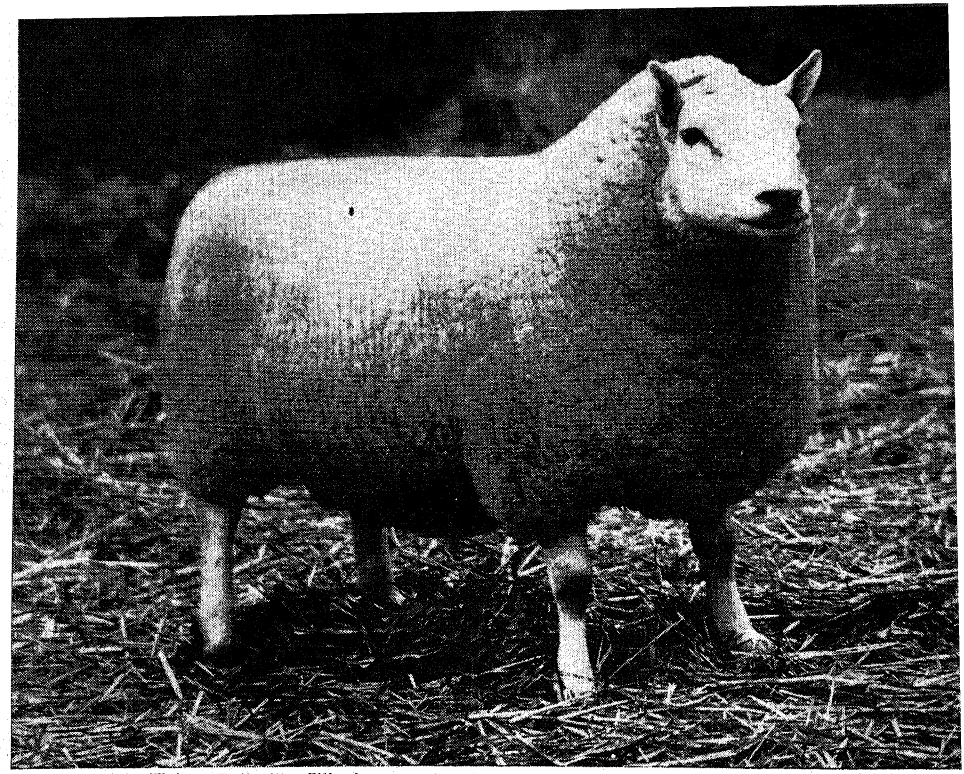
CHAPTER 11

The Cheviot

Cheviot sheep have definite characteristics that have become well fixed through many generations of breeding. Although history does not ascribe a definite origin to the breed, it is one of the oldest, for it has been in existence for about 200 years or longer. During this time its features have very probably been modified, but the hardiness needed for a continued existence under severe climatic conditions has been retained, and few breeds are apparently better able to withstand cold, stormy weather. Despite this ability the Cheviot has not been found so suitable from other standpoints as some other breeds and, hence, does not constitute an important percentage of the sheep population of the United States at the present time.

Size. The Cheviot is a small breed. Rams at maturity and in good condition weigh from 160 to 200 pounds, and ewes range from 120 to about 160. Under very good conditions heavier weights are secured.

Form. Cheviots are generally lowset, thick, and well proportioned, but the body does not give the impression of heavy muscling or of ruggedness. Rather, the general appearance is of refinement. The Cheviot is a hill breed and as such is very active and alert. Along with these features many of the breed have rather light shoulders that are somewhat sharp on top. The ribs are fairly well sprung, the loin is wide, and the hindquarters are full and deep. The large size of the hind leg in the region of the thigh is often quite surprising. The legs are strong and clean. This is also true of the feet and pasterns. The quick movements of the Cheviot reflect its active temperament. The breed is one of the most stylish. Part of this is derived from its general conformation, part from the carriage of its head, and part from the placing and carriage of its ears. Coarseness which would detract from its stylishness is disliked by breeders.



Courtesy Alvin Helms, Belleville, Illinois

This ram shows the alertness, quality, and color associated with the Cheviot.

Wool. Fleece weight is not one of the Cheviot's strong points. Flocks shear from 5 to 7 pounds after a growth period of twelve months. The wool has little yolk and is therefore usually light in its loss of weight during scouring. The fleece has moderate density and in a year's time will reach a length of 3 to 4 inches. The wool is strictly of medium grade with respect to fineness. Often it is bright, and there are very few, if any, cases where there are dark fibers in all parts of the fleeces, although, occasionally, black spots are found. Fleeces sometimes show a hairiness in the region of the thighs, and there are also some with considerable kemp.

The wool extends only to the back of the ears, and there is no wool on the head. The legs are also free of wool below the knees and hocks. There is very little wool on the underline.

Characteristics. Cheviots' general features combined with their clean, alert appearance and refinement make them very attractive. It is this that has made them favorites for use in "decorating" a small pasture near a country home. The face is white. The

nostrils, lips, and feet are black. Sometimes black spots are found on the legs, ears, or face. These are permissible, but tan-colored areas constitute very serious objections. The profile of rams is often Roman, but that of ewes is generally straight. Both sexes are hornless, although scurs are sometimes found on rams. These are not very objectionable. The ears are of medium length and are carried erect. Drooping ears would be considered a serious fault. The eyes are prominent and bold, and the head of the Cheviot reflects its active temperament. The skin is pink.

Utility. Hardiness rather than growthiness characterizes the Cheviot lambs. They are of small size at birth, usually from seven to nine pounds, and since they are not especially large at maturity, they do not gain so fast as lambs of larger breeds. The lambs are, however, probably hardier at birth than the lambs of any of the other common medium-wool breeds. The ewes are nervous, but they are good mothers, although they are by no means such renowned milk producers as the Dorsets. The lambs are seldom if ever overweight for markets desiring light lambs. Most Cheviot lambs do not fatten well at weaning age. As yearlings they produce meat of exceptional quality. Cheviot rams are active breeders, and the ewes are likely to produce an average number of twins, but the breed is not rated as unusually good in prolificacy.

In the ability to graze on hilly pastures, the Cheviot is surpassed by few breeds. In its native country, only the Black-faced Highland is considered its superior. Because of the Cheviot's activity, scant pasturage is not considered a disadvantage to its production. Except for other factors, the Cheviot might have become widespread on the ranges of the West. Rangemen have found them too small, too light shearing, especially when run under range conditions where there is heavy brush which pulls considerable wool from them; and the lack of a pronounced flocking instinct makes them difficult to herd in rough country.

Cheviots and Border Leicesters have been crossed extensively in Scotland and northern England to produce what are there called half-bred ewes. Such ewes are popular as lamb producers whether bred to half-bred rams or to rams of the same breed as the sire. There has been no comparable development in this country, and in no section has the Cheviot gained wide usage for crossing.

Standard of excellence. A handbook about Cheviots issued by the association of breeders contains a detailed score card from which the following somewhat abbreviated form is taken.

GENERAL APPEARANCE		15
Size. Fully mature, good flesh, rams 160 to 200 pounds; ewes, 120 to 160 pounds	5	
Appearance. Alert, symmetrical, compact	5	
Form. Straight top and underline, deep, broad, low-set; fine but strong bone	5	
HEAD AND NECK		15
Head. Medium length and breadth	3	
Ears. Thin, medium length, erect	2	
Mouth. Strong, thin lips, large nostrils	3	
Eyes. Large, clear	1	
Face. Straight or slightly arched in ewes, more arched in rams; nose black	2	
Neck. Short, thick, smoothly set	4	
FOREQUARTERS		12
Shoulders. Smooth, compact, well covered	4	
Breast. Deep, wide, and full	6	
Brisket. Broad, well rounded, legs apart	2	
BODY		18
Back. Straight, broad; thick, even flesh	5	
Heart girth. Full and deep	4	
Ribs. Well sprung	2	
Loin. Wide, thick, well covered	5	
Skin. Pink, no dark coloring	2	
HINDQUARTERS		15
Hips. Wide, level, and smooth	2	
Rump. Long, level, wide at dock	3	
Twist. Deep, wide, full, firm	3	
Flank. Full	1	
Thighs. Full, deep, and wide	2	
Udder or scrotum. Well formed, large	4	
FLEECE		25
Weight. 9 pounds for rams; 7 pounds for ewes	5	
General. Long, dense, even; covering body (including underline) from poll to knees and hocks	10	
Grade. One-fourth to three-eighths blood combing; distinct crimp; light yolk; bright and soft	10	

Distribution. The Cheviot has not gained wide distribution in any country of the world. Its strongholds at present are apparently in its native home and in parts of the United States. There are scattered flocks here, especially in the eastern and central states.

Registration. The American Cheviot Sheep Society resulted from a consolidation of early organizations. It has been in existence since 1900. Its headquarters are now at Catskill, New York.

CHAPTER 12

The Corriedale

The Corriedale was developed in New Zealand and Australia and represents another effort to combine into one breed some of the features of two breeds, neither one of which was considered as possessing the utility needed in one of the great sheep-raising countries. The breed is comparatively young, as its development has not yet extended over a century. It is essentially another effort to evolve a sheep that would be satisfactory for two purposes—wool and meat. Whether there is any such thing as a dual-purpose type may be an academic question, but there is nothing that is entirely academic about the fact that sheep are kept for the fulfillment of dual usefulness in the great majority of instances. That a breed established through crossbreeding would possess features not possessed by either of the parent breeds would not be expected except as these are blended in inheritance. Since neither of the breeds used in developing the Corriedale—Merinos and Lincolns—met producers needs, and yet both had some of the things desired, the two were crossed. Although the Corriedale met some requirements better than either of the parent breeds, no breed has yet been found that meets all requirements fully. Claims, unsupported by facts, are made by the proponents of all breeds, and the Corriedale, like many other breeds, has failed to justify all claims made for it.

Size. The Corriedale shows considerable range in weight, although rams in good condition at maturity generally weigh from 185 to 250 pounds and ewes, from 125 to 185. In the United States greater emphasis is placed on size in the range areas than in some of the farm areas of the central and eastern states.

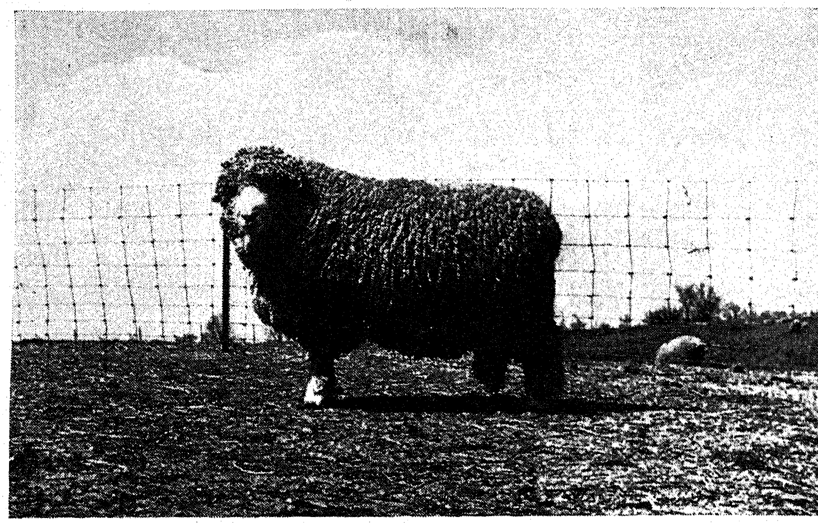
Form. The general form desired in Corriedales is that of a good meat-type animal. The better specimens are satisfactory in form. These show a moderate lowsetness, along with width, depth, and fullness of body outline. In some of the smaller animals the legs are shorter and the body more compact than is needed for a

Courtesy M. Moncreiffe, Big Horn, Wyoming

Corriedales, like other breeds, show considerable variation in general type. The small, compact type usually favored in the show ring is not considered most useful by market-lamb raisers.

highly useful sheep. Many Corriedales do not show the form needed to meet high standards of meat-type animals. There is often a tendency to narrowness in the chest and a lack of fullness in the hindquarters. In such cases the animals reflect most strongly their Merino ancestry. In handling qualities in the region of the back and loin, the breed is not of the best.

Wool. This is the strongest feature of the breed. The fleece represents essentially a blend of the two types of wool carried by the parent breeds. The wool is of medium fineness, usually three-eighths blood; exceptional length, brightness, softness, and a pronounced distinctness of crimp are its main qualities. Many Corriedales carry fleeces that are four inches or more in length in a year's time. The fleeces are dense, comparatively free of yolk, and show a light shrinkage in scouring. Fleeces generally range from ten to twelve pounds in weight, but some are at least fifty per cent heavier than these weights. Corriedale wool, if produced under good conditions, is the type that will command a top price. The wool extends well over the body and on the lower parts of the legs.



Courtesy C. J. Stover, Muncie, Indiana

A Corriedale ram, a prominent show yard winner, is shown here in unfitted condition.

Characteristics. The face, ears, and legs of the Corriedale are white, although black spots sometimes occur. These spots are allowable, but brown spots are considered as a defect. The head is medium in size but broad and strong in the best animals. Both sexes are hornless, although rams that have scurs sometimes appear. The face should be comparatively free of wool below the eyes, as wool blindness is a serious defect. The ears are of medium size and are carried horizontally. The skin is pink.

Utility. The lambs are of medium size and hardy at birth and grow at a reasonable rate, although slower than the lambs of such breeds as the Hampshire. They have no special outstanding merit as market lambs, but they do yield good carcasses. Most of the famous freezer lambs that are exported from New Zealand are the result of mating Corriedale ewes to other than Corriedale rams. At the United States Sheep Experiment Station in Idaho, 1,184 Corriedale lambs averaged 69 pounds at weaning time as compared with 71 pounds and 77 pounds for Rambouillet and Columbia lambs, respectively. More of the Corriedales were suitable for slaughter than was true of the other breeds.[1] The ewes are fair in

[1] U.S.D.A. Cir. 308. 1934.

prolificacy and as milk producers. A lamb crop of 125 would be a reasonable expectation.

Although the Corriedale has a good constitution, there are many rangemen who have criticized the breed as being too "fine." This implies that the bone is not heavy, and there is a lack of the sturdy robustness desired. The Corriedale has good flocking tendencies, and they are therefore easy to herd.

Standard of excellence. The following standard and scale of points are based on the description and scale adopted by the New Zealand Corriedale Association.

GENERAL APPEARANCE. Should give the impression of a hardy sheep, of great constitution. Rams of great character and bold outlook. Equal regard to carcass and wool.

Head. Small but broad and strong. Rams masculine; wide, open nostrils; no horns; dark nose preferable. Black but not brown spots allowable. A good top-knot of wool, clean but not bare face. Wool blindness a defect.

Neck and shoulders. Broad, strong neck; shoulders wide and deep; brisket deep and wide.

Middle and ribs. Ribs deep and well sprung with no dip behind shoulder.

Back and loin. Long and level. Loin very broad with a good depth of lean meat.

Hindquarters. Thighs well apart and deep, giving a large well-shaped leg of mutton.

Bone. Legs moderate length, well apart, and squarely under sheep, good but not too heavy bone. Well-formed feet, dark color preferred.

Wool. Dense, good style and length, even quality, well-defined crimp with good luster and even tip. 56's spinning quality. Coarse, straight-fibered, hairy wool on any part most objectionable. Strong, robust fleece desired on rams.

Weight. Stud rams 185 to 250 pounds; ewes 125 to 185 pounds.

Scale of Points:

GENERAL APPEARANCE AND STYLE		15
FORM AND CONSTITUTION		40
Head	5	
Forequarter and neck	7	
Middle and rib	7	
Back and loin	7	
Hindquarter	7	

Bone	4	
Handling	3	
WOOL		45
Quality and character	9	
Length and staple	9	
Density	9	
Covering	9	
Evenness	9	

Distribution. Corriedales have been exported from New Zealand and Australia to many other countries. In the United States they were first brought into Wyoming late in 1914, and from there they have spread into the other western states. There are now flocks in the central and eastern states also. In many cases the breed is proving satisfactory, but in others there is still some question of its worth, pending further trial.

Registration. The American Corriedale Association was organized in 1916 and records Corriedales in this country. The association has headquarters at Laramie, Wyoming. A proposal for a register of merit based on individual excellence and productivity has been presented to the society, but at this time has not been acted upon.

CHAPTER 13

The Columbia

The Columbia has been developed since 1912 and hence is the youngest breed to have gained considerable prominence. Its development has been guided by members of the United States Department of Agriculture, although others have been active during the last half of the period since its establishment. Its parentage was Lincoln rams and Rambouillet ewes. After the cross was made, the offspring were culled and selected and interbred with no further introduction of the particular breeds. The object was to develop a breed of sheep especially adapted for a particular region. That region was the intermountain section of the West. The Columbia has spread to other sections, however.

A reasonable number of the aims in mind when the work was started have been accomplished. With such differences in the parentage as existed between the Lincoln and the Rambouillet, it should not be expected that the breed would be standardized at this time, but most Columbias reproduce with remarkable trueness to type when compared with breeds that have been established for far greater periods. The emphasis has been wholly on utility for certain purposes, and no fads have beset the breed to hinder its utility characteristics.

Size. It was intended that the Columbia should be larger than the Corriedale. The average weight of 1,517 Columbia ewes was 134 pounds compared with 116 pounds for 1,508 Corriedale ewes maintained under the same conditions.[1] Columbia ewes generally range in mature weight from 125 to 190 pounds. Rams weigh from 225 to 275 pounds, and with supplementary feeding it is not unusual for rams to weigh in excess of 300 pounds.

Form. The general form desired is a large, robust frame with reasonably good meat type. There has been no great emphasis to develop a very lowset type as the sheep are for range use, and they

[1] U.S.D.A. Cir. 308. 1934.

Courtesy U. S. Sheep Experiment Station, Dubois, Idaho

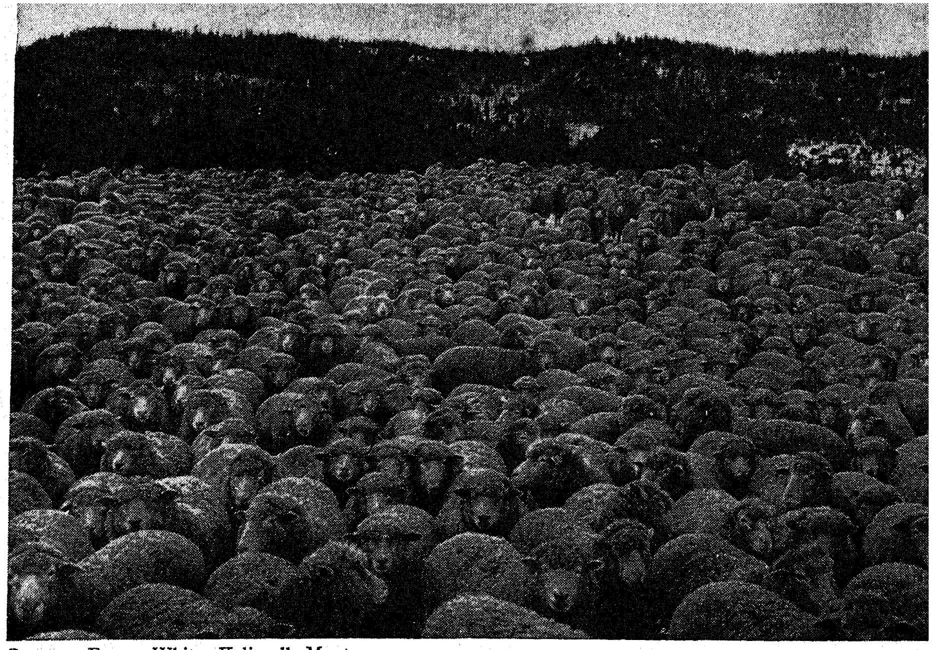
The Columbia is a large, clean-faced, medium-wooled breed.

are expected to be able to travel long distances. They would be described as moderately upstanding, and for the purpose in mind this is no disparagement of the type. The general body form is that of a large sheep with good depth and width. Not all have the full hindquarters desired, but there are some that show good development of the region. Fleshing or handling qualities are not of the best from a showyard standpoint, but from the market standpoint the breed average is good.

Wool. The fleece is relatively long, averaging about 3.5 inches, but many fleeces attain a length of 4.5 to 5.0 inches in a twelve-month period. Under range conditions the fleeces of 1,322 ewes averaged 11.7 pounds in weight.[1] The wool is relatively light in grease, and the usual grades are three-eighths and quarter blood. The wool is not of a fancy type, but it does possess good commercial working properties. It extends to a line even with the eyes. The body is well covered, although there is no effort to secure wool below the knees and hocks.

Characteristics. The Columbia is a white-faced breed, and

[1] U.S.D.A. Cir. 308. 1934.



Courtesy Ernest White, Kalispell, Montana

This flock of Columbia ewes shows the size, form, heavy fleece, and clear face desired by many range sheepmen.

the face is free of wool. Both sexes are hornless. The general appearance is of ruggedness, and the features are such as to give an impression of sturdiness rather than refinement. The ears are of medium size and are carried horizontally. The skin is pink.

Utility. This is intended to be a sheep useful for range purposes. The ewes are reasonably prolific for such conditions and are good milkers. The lambs are large at birth, but there is no special difficulty at lambing time. Growth is rapid. Fattening qualities are rated fair to good. The ewes are very suitable for crossing with Hampshire, Suffolk, or other medium-wool rams. Columbias have a good herding instinct.

Standard of excellence. At the present time Columbia sheep must be inspected before they are accepted for registration by the association of breeders. The following standard of excellence has been adopted as a basis for inspection.

Size. Mature Columbia rams should weigh 200 to 275 pounds; mature ewes 130 to 200 pounds, depending on the conditions under which they are raised.

Fleece. Columbia ewes should shear an annual fleece of 12 pounds or more depending on environmental conditions. The fleece should

grade one-half, three-eighths, or one-fourth blood, but should not show a greater variation than two grades.

Head. Columbias of both sexes are hornless and open-faced.

Color. Hair on the face should be white. The occurrence of black pigment on the nostrils and hooves and in small spots on the ears is not objectionable.

Ears. Moderately long and free from wool but covered evenly with a coat of white hair.

Neck. Moderately short, neatly attached, full, free from wrinkles and folds.

Shoulders. Wide, tightly laid on top and even with backline.

Chest. Wide and deep with forelegs set well apart.

Back. Level, wide, and strongly muscled.

Rump. Long and wide with dock carried well up.

Ribs. Well sprung, wide, and deep.

Thighs. Thickly muscled and well filled in the twist.

Legs. Set squarely under sheep, heavily boned and covered with white hair below the wool line.

Hooves. May be either white or black.[1]

Distribution. Most Columbias are found in the northwestern and western states, but there is a gradual spreading eastward into North Central States. A type of crossbred ewe similar to the Columbia, often referred to as "northwestern white faces," is popular in some areas of the Central States.

Registration. The Columbia Sheep Breeders' Association was organized at Bozeman, Montana, in 1941. The headquarters are at Fargo, North Dakota. All sheep are inspected before accepted for registration. Since 1941 approximately 11,000 have been registered.

[1] U.S.D.A. Cir. 308. 1934.

CHAPTER 14

The Leicester

The breeds of long-wooled sheep that are raised in the United States were developed in England. Although they may not all have the same foundation, it is probable that there was much similarity in the original stock, and some use was made of the Leicester in the course of the development of the other breeds. It is altogether likely that some crossing may have occurred too at more recent dates. In discussing long-wool breeds, it is customary to dwell at some length upon the accomplishments of Robert Bakewell, whose work with sheep improvement began about 1760. He is generally credited with effecting much improvement in the Leicester. While the student of sheep husbandry should not overlook historical matters, the immediate purpose is perhaps served by calling attention to the fact that Bakewell's methods were based on the selection of animals showing the closest approach to the qualities desired and using breeding methods that would concentrate these characters in the offspring. Bakewell is generally regarded as the first to make extensive use of inbreeding in livestock improvement. Except as later breeders have selected and bred along similar lines, there would be little present-day effect from efforts so long past.

Leicesters have had limited popularity in the United States. This is true of both the English Leicester and the Border Leicester. The two are regarded as distinct breeds in some countries, but here they are usually thought of as two types of the same breed. These, like the other long-wool breeds, are distinctly mutton type.

ENGLISH LEICESTERS

These are large sheep with some features which make them difficult to distinguish from Lincolns. In fact, if the characteristics of the breeds are not very well developed it is quite impossible to identify them with certainty.

Size. Mature rams will weigh from 225 to 250 pounds or

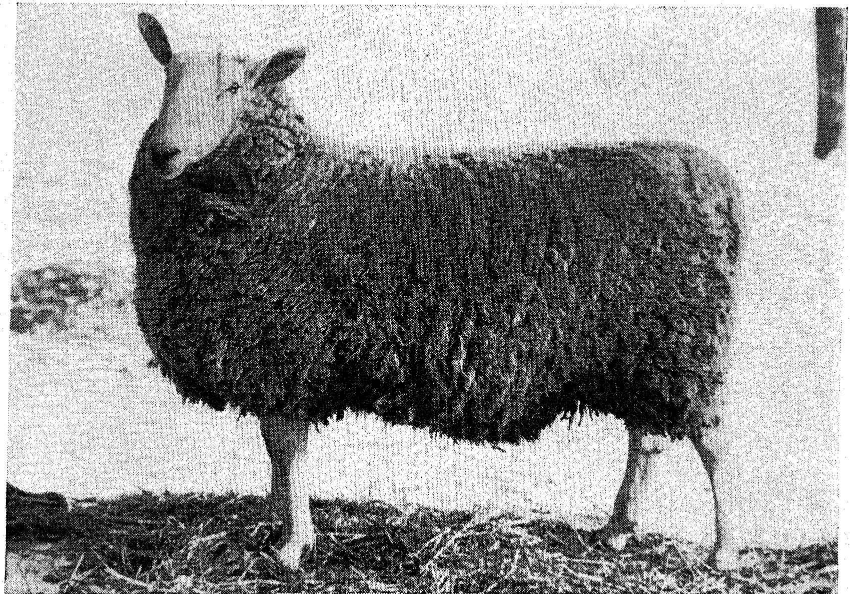
Courtesy J. A. Telfer, Department of Agriculture, Ottawa, Canada

The typical features of the English Leicesters are shown by this ram.

more, depending upon their condition. Usual weights for ewes are from 175 to 225 pounds.

Form. The body is massive and is inclined to be rectangular in general outline. The back is broad and strong, and fullness characterizes the hindquarters. The legs are moderately long, and Leicesters are considered as upstanding sheep. The neck is short in comparison with the proportional length of the rest of the body. The fleshing along the back in mature sheep is thick, but lambs are not exceptional in this respect. There is a small to medium amount of style. The legs (bone) are likely to be considered as somewhat light in structure if one is used to handling a breed such as the Hampshire.

Wool. There is a small tuft of wool on the forehead, and there may be a very small amount of wool on the cheeks. There is only a small amount of short wool below the knees and hocks. The wool reaches a length of seven to nine inches in a year's time. It is usually finer than the wool of the Lincoln or Cotswold, and generally the locks of the fleece are smaller and tighter than of the



Courtesy Ontario Agricultural College, Guelph, Ontario, Canada

The Border Leicester differs from the English Leicester in head, body, and fleece.

other two breeds. Most Leicester wools grade as braid. There is a long waviness to the fibers rather than a crimpiness, as found in finer wools. Fleece weights of ten to twelve pounds are common. There is comparatively little yolk, and most of the loss of weight in scouring is due to adhering dirt. The fleeces of Leicesters are loose or open compared with those of the medium-wool breeds. There are no black fibers.

Characteristics. The face of the Leicester is white. There are some Leicesters which have a bluish tinge to the parts not covered with wool. The lips and nostrils are black, and black spots are also found on the face and other parts. The head is long from the eyes to the nostrils, and most rams have a Roman profile. The ears are carried horizontally or very slightly above this position. The skin is pink. Both sexes are hornless.

THE BORDER LEICESTER

The Border Leicester is easily distinguished from the English type by the differences in the head, shape of body, and external ap-

pearance of the fleece. There is no wool on any part of the head of the Border type. It is similar to the Cheviot in this respect. The ears are less erect than in the Cheviot but more so than in the English Leicester. Compared with the English Leicester, the face of the Border Leicester is cleaner cut and a little more refined, although the profile is slightly to markedly Roman. The wool of the Border Leicester is shorter, denser, and has a purled or twisted tip. This characteristic tip and the absence of the usual locks of the fleeces of most long-wools are further means of identification. The body of the Border Leicester has a lighter and more graceful appearance, the head is carried higher, the neck is longer, and there is much more style than in the English Leicester. Border Leicesters are slightly smaller than the other strain.

Utility. Leicesters cannot be considered as being well adapted to modern sheep-raising requirements. While Border Leicesters are prolific and good milkers, the English type has been criticized in these respects. Good feed and pastures are needed, and even under such good conditions lambs do not finish at attractive weights. External fat rather than an intermingling of fat and lean characterizes the carcasses. There is only a moderate degree of hardiness, and there is apt to be considerable loss if these sheep are exposed to severe weather, as the wool does not afford so much protection as the wool of the medium- and fine-wool breeds. This condition is due to the looseness of the fleece and to its tendency to part along the center of the back, thus allowing the skin to become wet and the body chilled.

Leicesters have been used for crossing in England and Scotland and elsewhere. The Dishley Merinos of France are a result of crossing Leicesters and Merinos.

Standard of excellence. There is no standard guide for the judging or selection of Leicesters.

Distribution. Leicesters have never been numerous in any part of the United States, although, earlier, there were some prominent flocks in eastern Canada. It seems that there is scant likelihood of any important change with respect to the way in which the breed will meet present requirements, and further numerical declines are therefore to be expected.

Registration. The American Leicester Sheep Breeders' Association, established in 1888, seems to be inactive at present.

CHAPTER 15

The Lincoln

The fertile fields of Lincolnshire, England, produced large long-wooled sheep many years ago. Undoubtedly the native sheep have been improved, but many of the early characteristics have been retained. Part of the improvement resulted from the use of Leicesters, and part came from selection. The Lincoln has made an important contribution to the world's sheep industry, but as a pure breed it seems now to have passed its period of greatest usefulness. It does still have considerable importance, especially in some countries of the Southern Hemisphere. Size, fleece, and mutton form have been its chief features which have drawn the attention of sheep raisers.

Size. Massiveness is a generally recognized feature of the Lincoln. It is the largest sheep produced in England and the largest in this country. That it would lack somewhat in quality compared with smaller breeds is not surprising, but if size can make up for that lack the Lincoln is fully capable of making good in that category. Mature rams weigh from 250 to 350 pounds, and many exceed these weights. Rams weighing 400 pounds have been seen in exhibitions. Ewes of 225 to 250 pounds are not uncommon. The Lincoln is adapted to an abundance of feed; otherwise, these weights would not be reached.

Form. The typical Lincoln is quite remarkable in the symmetry of its body. It is deep, wide, compact, and smooth; and its legs are sturdy, well placed, and moderately short, giving the appearance of a big, lowset sheep. The head is strongly made, and the neck is short and symmetrical in its attachments. The ribs are well sprung and fully developed; well-fleshed specimens have tremendous width at this point. The loin and rump are wide, and in the best individuals the fullness of hindquarters is surpassed by few if any breeds. There are cases where the fleshing about the rump is rough and uneven.

Wool. No other mutton breed produces heavier fleeces than the Lincoln. The wool is light in yolk; yet the fleece weights range from 12 or 14 to 20 pounds after a year's growth. The wool is long, and fleeces of less than eight inches are considered too short to justify registration of the sheep. A length of twelve inches is not uncommon, although the average is perhaps somewhat less than that. That wool of such length would be coarse is not surprising. The fibers have a distinctive luster, which has caused such wool to be known on many markets as "luster wool." The wool hangs in long ringlets or locks and shows a broad, wavy pattern rather than crimp, as found in wool of finer quality. The wool on the thighs is sometimes straight and hairy, and a cotting tendency is also noted with some frequency. Density varies in all breeds, but Lincolns are not thought of as having other than open fleeces. There is the characteristic tendency for the fleece to part along the back. The wool extends over the body, but there is little below the knees. Often there is some below the hocks. As in the case of the English Leicester there is a small tuft on the forehead, but in some cases these locks are almost as long as is characteristic of the Cotswold.

Characteristics. Lincolns have white faces. It is desired to have dark nostrils, lips, and feet, but the former are sometimes more or less mottled. Spots also occur on the ears and legs and occasionally on the face. The ears are of a length in keeping with the size of the body. They are carried horizontally and inclined slightly forward. The faces of ewes show considerable refinement with straight profiles. Rams have a strong, square muzzle and show good strength in head features. The eyes are prominent, and the best rams have a bold, fearless expression. The Lincolns are hornless. The skin is always of a bright pink color unless the animals are unthrifty. Style is not a common attribute of the Lincoln, and the breed is not credited with an active temperament.

Utility. The main usefulness of the Lincoln at present is in crossing with smaller sheep to increase size and to give a greater length to the fleece. Such use has already been made of the Lincoln in the development of the Corriedale, the Columbia, and the Panama. Aside from its use in the establishment of new breeds, much crossing has been done merely for the production of ewes for range flocks. The newer breeds have reduced this activity to a considerable extent.

The breed is average in prolificacy and milking qualities, and

Courtesy H. T. Crandell, Utica, Michigan

This champion Lincoln ram shows the size and the long wool which characterize the breed.

the lambs grow rapidly. Lambs do not fatten at light weights, and they are usually too heavy to meet present-day market requirements. The carcasses carry considerable external fat, sometimes not evenly distributed, and the meat is not so fine textured as in some of the medium-wool breeds.

Large size and the lack of an active disposition limit the adaptability of the breed to localities of abundant feed. Lincolns cannot be given a high rating with respect to hardiness or constitution as they do not withstand cold, rainy weather well. This is partly due to the character of the fleece and its tendency to part along the middle of the back.

Standard of excellence. There seems to be no published standard for the breed in this country.

Distribution. There are few flocks of Lincolns in the United States. Most flocks are in the northern and northwestern states, and few are found in any of the southern sections. Lincolns have not spread over much of England, although they have been exported from there to most of the important sheep-raising countries. New Zealand and South America are now the leading Lincoln areas.

Some were imported from New Zealand to the United States in 1928, but they were much smaller than those generally raised here, and importations from any country are no longer made except in rare instances.

Registration. The National Lincoln Sheep Breeders' Association was organized in 1891 and now has headquarters at Marlette, Michigan.

CHAPTER 16

The Cotswold

The Cotswold, like the other long-wool breeds, has played an important part in sheep raising, but its popularity and prominence have declined with the change in the kind of products our markets demand. Rams were extensively used in parts of the West for the production of breeding ewes of good size and heavy fleeces. Despite this use the Cotswold has not figured in the establishment of any new breed in this country. Its native home is in the hills of Gloucestershire, England. It was improved through the use of Leicesters, but many of its qualities undoubtedly trace to those possessed by the native sheep found in the region since the time the country was occupied by the Romans.

The Cotswold is not unlike the Lincoln and Leicester breeds, both with respect to its characteristics and its suitability to present-day sheep production.

Size. Cotswolds are generally slightly smaller than Lincolns; mature rams weigh from 250 to 300 pounds, and ewes range from 175 to 225. Sheep that have two or more inches of fat on much of the body, as is the case with highly fitted show animals, weigh considerably more than the upper limits given. This breed, like Lincolns and Leicesters, is large not only with respect to weight but with respect to height and other dimensions of the body. Wither heights in excess of three feet have been observed.

Form. An upstanding, moderately high-headed appearance is characteristic of the Cotswold. The back is broad and the ribs well sprung. Other parts have typical mutton-type development, although it is not unusual for specimens of the breed to be low where the neck and the top of the shoulders join and to have rather drooping rumps. The hindquarters are usually full and deep. The legs are well placed, but the bone is not especially heavy.

Wool. The wool is long and grades as braid. A length of eight to twelve inches is not unusual, and a length of sixteen inches

34

Courtesy H. T. Crandell, Utica, Michigan

The Cotswold is a moderately stylish long-wool breed with long tufts of wool on the forehead.

in fourteen months' growth has been claimed. The fleece hangs in large open ringlets or curls, not only on the body but also over the face. There is a tuft of wool on the forehead, and for show purposes this is not removed. As a consequence, the locks hang down over the face, reaching to the tip of the nose. There is, however, no wool growth on the face or cheeks. The main fleece stops at the knees and hocks, but there may be some short, rather fine wool on the lower legs. The wool covers the main parts of the body, but that on the underline is shorter than the parts on the back and sides. Coarse, hairy wool about the britch or thighs is not uncommon. Fleeces are expected to weigh at least ten pounds and upward to fifteen pounds or more. Yolk is not particularly abundant, but chaff and dirt cling to the wool in considerable amounts.

Characteristics. The face is white, although grayish specks and a bluish tinge are common. The nostrils, lips, and the skin

about the eyes are black or mainly of that color. The legs are white or flecked with white and gray. The skin on the body is a bright pink of a deep hue. Cotswolds are hornless, but rams occasionally have scurs.

In the typical Cotswold there is a characteristic breediness which is difficult to define but which arises from the combination of carriage, ringlets of wool, and the refinement of head, together with a carriage of the ears, which give the impression of more alertness than in either the Lincoln or English Leicester but less than in the Border Leicester. The ears of Cotswolds are fairly long and very slightly erect. The profile is straight in most rams as well as ewes.

Utility. Cotswolds possess approximately the same merits and deficiencies as the other long-wool breeds. Lambs grow fast but are not inclined to fatten easily or at light weights. Carcasses are therefore heavier than generally wanted under present conditions. The dressing percentage of fat lambs is satisfactory, but the meat is not credited with the fineness of texture found in the best carcasses of medium-wool breeds, although muscular development may be good. Cotswolds are generally considered somewhat more hardy and active than Lincolns and hence adapted for use where feed is less abundant and accessible.

In prolificacy, milking qualities, and maternal instinct they are above the average for long-wools, but they are probably excelled by many Border Leicesters.

Rams have been widely used for crossing on Merino and Rambouillet ewes in the western states. At one time the breed was the most widely used of the long-wools for that purpose.

Standard of excellence. No scale of points has been adopted by breeders.

Distribution. The North Central States and Oregon and Utah were the centers of production. While flocks were never numerous, some were of exceptional quality. Numbers have shown a significant decline in late years. Cotswolds are not found extensively in England outside of the section where the breed developed.

Registration. The American Cotswold Sheep Association was founded in 1878. The office of the present association, The American Cotswold Record, is located at Union Stock Yards, Chicago, Illinois. Flock books are no longer published.

CHAPTER 17

★ *The Romney* ★

The Romney, Romney Marsh, or Kent sheep, as they are variously called in their native home in southern England, have for centuries disproved the statement that sheep cannot be raised on low, wet lands. This area of England is moist, cold and only slightly above sea level, produces a heavy vegetation, and requires close stocking to graze down the grass so that it is utilized to advantage. Romney sheep, similar in many respects to Lincolns and probably improved through the use of Leicester rams, thrive with little protection under the bleak conditions on the pastures. Claims that these sheep are less susceptible to such ailments as foot rot and internal parasites, while not thoroughly substantiated, may possibly have some basis in fact, for there is some evidence that sheep are not all equally susceptible to parasitism. Despite such claims the Romney has not become popular except to a limited extent in this country. They are, however, numerous in the north island of New Zealand, where breeders seem to have found them especially suitable and have affected considerable improvement in certain qualities.

Size. Romneys are large, rugged sheep, but they have less scale and shorter legs than other breeds classed as long-wool types. Mature rams weigh from 200 to 250 pounds, and ewes from 175 to 200 pounds.

Form. Lowsetness and ruggedness characterize the general form of the Romney. The body is deep and wide with a full development of the brisket and hindquarters. The neck is fairly short, and the head is carried only slightly above the level of the top line. The body is usually smooth, although strength of back and fullness back of the shoulders are sometimes lacking. The legs are sturdy and strong, with good bone.

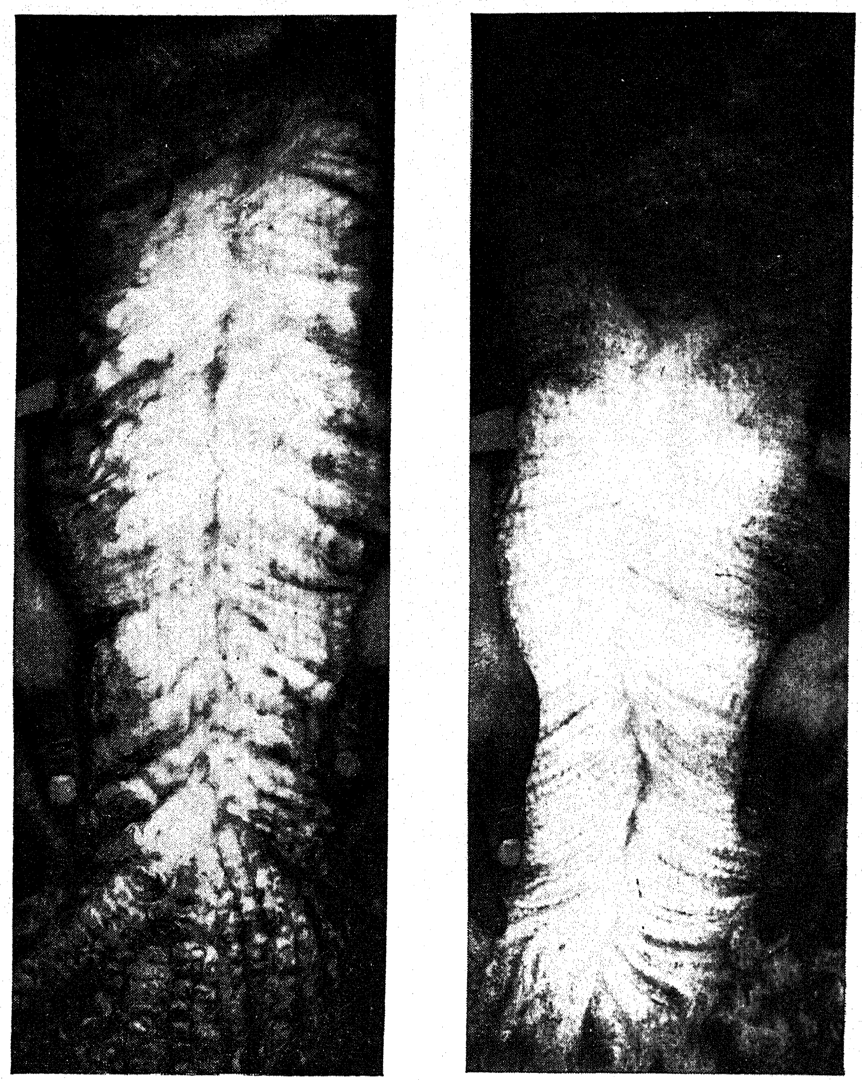
Wool. While classed as a long-wool type, Romneys do not have wool that is particularly like that of the Lincoln, Leicester, or

Courtesy American Romney Breeders' Association

The Romney is a strongly built mutton type.

Cotswold. The Romney fleece is much more compact, the fibers are shorter and finer and have less luster than the fleeces of the other breeds in this group. Romney wool may grade from braid to quarter blood on the markets. Thus, it is sometimes as fine as some of the wool obtained from medium-wool breeds. In general, the wool covers the body, but there is little wool below the knees and hocks. There is a tuft of short wool on the forehead, but the rest of the head, except the lower part of the cheeks, is free of wool. Fleece weights range from ten to twelve pounds, although some exceed the heavier weight given. The fleece does not have the tendency to part along the back and hence affords good protection during rainy weather.

Characteristics. Romneys are hornless. The face and legs are white. The hoofs, nostrils, and lips are dark-colored. The forehead is broad, and there is an indication about the head of strength and stamina. The ears are not heavy, but they are large enough to



Courtesy University of Illinois

There are differences in the fleeces of the Lincoln and the Romney: left, the Lincoln has all the typical features of the long-wool type of sheep; right, the fleece of the Romney is similar in many respects to wool of the medium-wool types.

be in harmony with the other features. The general impression gained from an inspection of the head is of an animal with only a fair degree of alertness, yet Romneys are active grazers.

Utility. Hardiness is a conceded characteristic of the Romney. While they are not particularly adapted to hot, dry climates they do withstand inclement weather well, and they are able to thrive at higher elevations than those under which they were developed. They do not have highly developed flocking tendencies, but they are quite easily handled. They are good grazers and yield meat that is said to be of better quality than that of other long-wools. The Romney is suitable for crossing with either fine- or medium-wool ewes, and several efforts to establish new breeds through its use have been made. Whether such breeds as the Romeldale will prove acceptable for extensive use has not been fully demonstrated at this time.

Romney ewes are only fair in respect to prolificacy. While many of them drop twin lambs, the breeders have not selected them for highly fecund sheep. The lambs are large and sturdy, and the ewes suckle well. The lambs grow fast, and they may finish more easily than lambs from most fine-wool or other long-wool breeds.

Standard of excellence. American breeders adopted a very detailed score card as used in some of the colleges in Australia. This standard of excellence is descriptive of many of the things desired in Romney sheep but like all other such score cards is impossible of exact interpretation because of the lack of exactness in the meaning of the terms and the absence of definite measures for all points except weight. Nevertheless, these standards must serve until such time as other means are developed. The full detailed standard is not included here as the following is a summary of the points in the standard for Romney rams "for breeding purposes and wool production."

BODY		60
General appearance and size. Large frame, straight back, rather short legs, weight about 240 pounds	8	
Quality and breeding. Large head, white face, nice forelock, coal-black nose and muzzle, deep body, heavy bone, good carriage	6	
Head features. Wide, level between ears, hornless; ears large, set on side of head; face broad, aquiline, large nostrils; eyes large and wide apart	11	

Neck. Well set on shoulders, strong, thick	2	
Shoulders. Wide, level with back, well rounded, fleshy	5	
Chest. Wide, deep; brisket fairly broad	4	
Topline. Straight; back wide, flat, meaty loin; ribs well sprung	7	
Rump. Wide, long; tail almost level with chin	7	
Twist and underline. Broad, arched; underline fairly straight	5	
Legs. Stout, broad knees, white; hooves large, black	3	
Wool covering. Absence of bare skin to any extent under arm and inside of thighs and hind legs	2	
FLEECE		40
Quality and character. Bright, even, distinct wave; clear white; tip open	12	
Length. Staple must be over 7 inches	3	
Texture. Soft, pliable and elastic	5	
Soundness. Capable of standing stress, robust	6	
Trueness. Even structure, uniform in all parts	4	
Density. Close, thick growth	3	
Color. Demi-lustre, clear white; skin pink, clean	6	
Yolk. Fair supply, pale yellow color	1	

Distribution. There are few Romneys in this country. Some have been produced in the Central States, but they are most numerous in the Pacific coast states. They have been widely accepted in New Zealand and to a lesser extent in Argentina and Australia.

Registration. Matters concerning the promotion of the breed and the recording of purebred Romneys are handled by the American Romney Breeders' Association, which was organized in 1911 and which now has headquarters at Corvallis, Oregon.

CHAPTER 18

The Merinos

The various strains and breeds of fine-wool sheep of the present time originated from the sheep of Spain. Fine-wool sheep represent Spain's chief contribution to the livestock industry of the world. There are many fascinating chapters of history dealing with the Spanish sheep industry, but it will suffice for the purpose of the study of the breeds of sheep as they exist today to point out that the Spanish Merinos possessed most if not all of the features now found in such sheep. Changes have occurred as emphasis was placed upon special characteristics, but these changes have been wrought within the Merino, and apparently there has been no infusion of the blood of other types. The two outstanding peculiarities of the Merino are the fine-wool and the strong flocking instincts. Regardless of personal likes, it is true that no type of sheep has played so important a part as the various Merino strains in most of the leading sheep countries of the present. These Spanish sheep are the foundation of the world's commercial wool industry, which is built primarily upon the finer grades of wool. They are also the basis of the close-herding tendency by which one man, usually assisted by a dog, has been able to watch over the welfare of from one thousand to several thousand head. Their influence has also been seen in the development of other breeds. Great as their contribution has been, it may have been even greater had not certain developments occurred that proved handicaps to the Merino's utility. Some of these handicaps arose through a neglect of emphasis upon some feature, such as body form, and some through an overemphasis on items such as extremely wrinkled bodies or excessive face covering.

The breeds of fine-wool sheep in the United States are all, essentially, different types of Merinos. The differences among them are due to selection in their early development for a certain type and to later improvements as conditions demanded. The Rambouillet is not often thought of as a Merino, but its basic origin

Courtesy D. S. Bell, Ohio Agricultural Experiment Station

The lack of suitability for modern sheep raising has made the "A" type Merino practically obsolete.

was essentially the same Spanish Merino stock from which the American and Delaine Merinos were developed. In the past much emphasis was placed upon the breeding of various strains, but there is little of importance in many of these claimed differences. It is, for example, quite impossible to establish any difference in breeding between the American and Delaine or "C" type Merinos.

Types. Three types of American Merinos have been recognized for the last half century. These types are based upon the differences in appearance due to the presence or absence of folds in the skin, but the dividing line is by no means always clear-cut.

The "A" type. The "A" type has the greatest development of folds or wrinkles. In this type skin folds extend from the head to the dock, covering the entire body. The direction of the folds is generally around the body, but there are folds, especially in the region of the thighs, that are irregular. Many "A" type Merinos show folds in the skin about the cheeks and lower jaw. Folds completely encircle the neck and back. The purpose in the development of these folds was to provide a greater area of skin for the growth of wool. Meat production was of no consequence, and all

the emphasis was upon fleece. The features of the fleece most emphasized were fineness, density, and weight. Such important matters as length and uniformity were overlooked in the desire for other qualities. It has been definitely established that skin folds and a lack of uniformity of fiber fineness are associated. Density is often thought to exist when, in reality, it does not. Short wool may have the appearance of being denser than long wool, but the opposite may be true, and especially is this likely to be the case when the short fleeces contain an excessive amount of yolk or grease. Much of the weight of the fleeces of "A" Merinos was not due to the amount of wool fiber but to the yolk and adhering dirt. Fiber yield is determined by the density of growth, length of fibers, and the area covered. Merino breeders overlooked the fact that fleece weight and fiber yield are by no means the same. The enormous fleece weights credited to Merinos have little importance, for many were for fleeces of more than a year's growth, and the shrinkage or loss of weight when washed was so great that the yield of wool fiber was little if any greater than generally obtained from fleeces that weighed far less "in the grease."

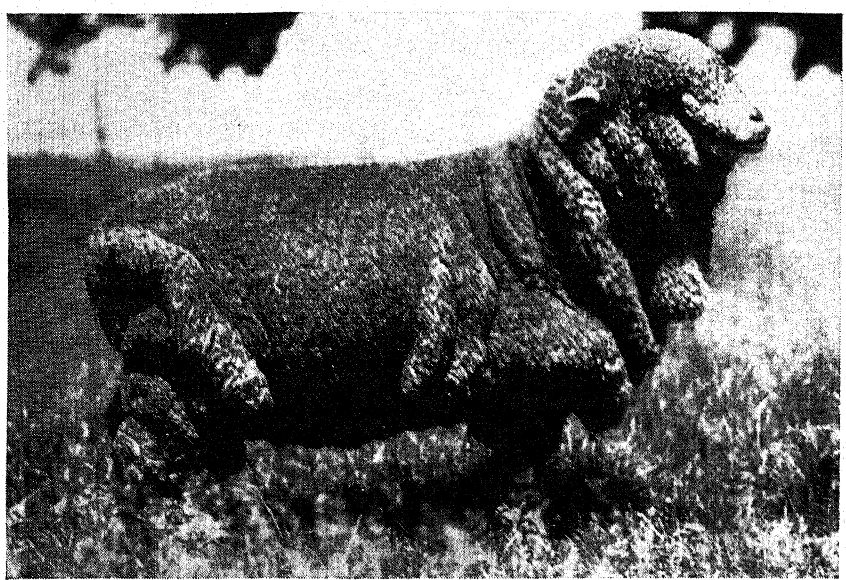
Size. Mature rams weigh from 130 to 160 pounds and ewes from 90 to 120 pounds.

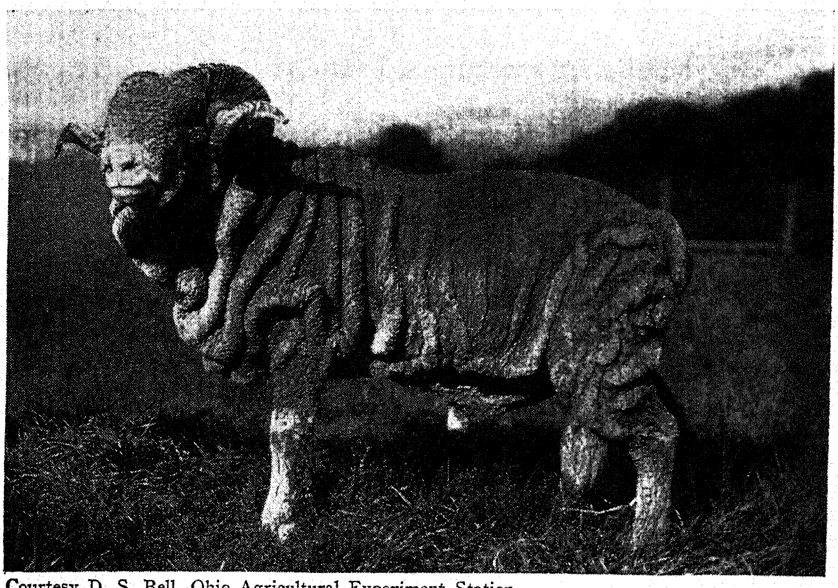
Form. The form of the "A" type Merino is not good from the standpoint of conformation. The legs are short, and the body is compact, but it is lacking in smoothness and fullness. Fleshing qualities are poor.

Utility. The lambs are small at birth, and growth is slow as the ewes are not good sucklers. Prolificacy is not as good as in several other breeds. Wool production is the chief merit of the type, but the kind of wool is not so suitable as wool with more length of staple. The type is now practically obsolete.

The "B" type. The "B" type has fewer skin folds than the "A" type. Most of the folds are about the neck, although there may also be some at the region of the fore and rear flanks and about the dock and thighs. In general, the "B" type represents a larger sheep with less emphasis upon wool and, consequently, somewhat better body form. The weight of the wool in the grease may not be so great as for the "A" type, but the amount of fiber is not necessarily less as there is a considerable reduction in the amount of yolk and often some increase in staple.

Size. Rams weigh from about 145 to 175 pounds. Ewes weigh





Courtesy D. S. Bell, Ohio Agricultural Experiment Station

The "B" type has less folds than the "A" type, but it is limited in usefulness and may soon be further replaced by sheep of lighter pelts. Top, the ewe is in full fleece. Bottom, the ram was recently shorn. The heavy hide and angular body, neither of which are associated with high-quality wool or meat production, are well shown by the ram.

from 100 to 135 pounds, and they thus average about ten to fifteen pounds more than "A" type ewes.

Form. "B" type Merinos are fuller in the heart girth and hindquarters and have somewhat better fleshing qualities than most "A" type sheep.

Utility. Since the "B" type comes closer to representing an animal useful for the production of both meat and wool than does the "A" type, it must be assigned a greater degree of usefulness in present-day sheep husbandry.

The "C" type. The "C" type, or Delaine, is free of folds or wrinkles on practically all parts of the body, although there may be a small "apron" or neck fold. Much controversy has existed in the past regarding whether "C" type Merinos could be bred as such. Many contended that the best "C" type sheep had to be mated with "A" or "B" types in order to retain some of the desired fleece qualities. Delaine wool is much longer—2½ to 3 inches in twelve months' growth, lighter in grease, and there are no wrinkles producing a lack of uniformity throughout all parts of the fleece. This is the best fine-wool obtained in this country.

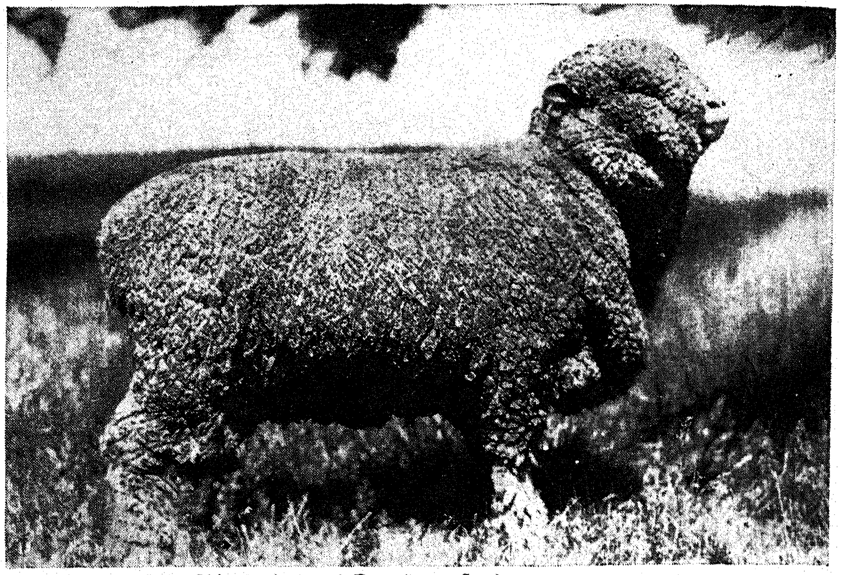
Size. Delaine rams weigh from 150 to 200 pounds and ewes, from 110 to 150 pounds.

Form. The body of the "C" type is much straighter and smoother than is true of either of the other types. The body is wider and fuller through the mid portion, and the twist and thighs are better developed. The fleshing qualities also are superior to those of the other types.

Utility. Delaine-type Merinos must be credited with considerably greater usefulness than either of the other types at the present time. This is due to the better combination of wool and meat qualities and the production of better quality wool as well as a higher grading carcass. Lambs grow somewhat faster and can be finished for market with fair satisfaction, although they are often of greater age, than is true of the best medium-wool types, when ready for marketing. Delaine ewes are widely used for crossing with Dorset and other medium-wool rams for market lamb production.

A study of importance concerning wool production of Merino sheep was reported by the Ohio Experiment Station.[1] The data show that while under practical conditions some variations occur in the rate at which wool grows, under uniform conditions the stage

[1] Ohio Agr. Exp. Sta. Bul. 571. 1936.

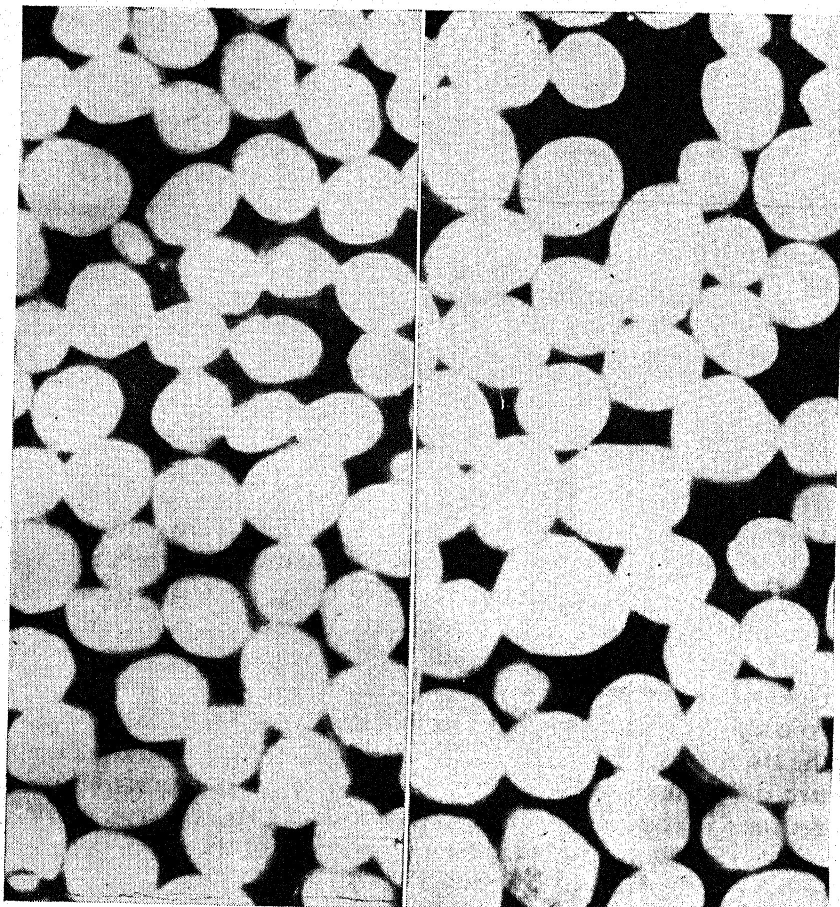


Courtesy D. S. Bell, Ohio Agricultural Experiment Station

This ewe is somewhat old-fashioned because the "C" type is now practically free of folds. Emphasis is now on longer staple wool and good body form.

of wool growth does not influence the rate of growth. These studies also showed the importance of measuring wool production on the basis of clean wool rather than on the basis of grease weight. The work related to a comparison of American Merinos and Merinos imported from Tasmania. American Merinos of a moderately wrinkly type produced an "average of from 3.68 pounds to 5.05 pounds more of unscoured wool per head in twelve months than Tasmanian sheep kept under similar conditions." It was also determined that the "weighted average yield of clean wool produced by the foundation flock of American Merinos was found to be 35.26 per cent of the weight of sheared wool, and for their female offspring, 37.03 per cent of the weight of sheared wool. The corresponding data for the two flocks of Tasmanian Merinos were found to be 52.15 per cent and 52.23 per cent of the weight of the sheared wool, respectively."

The average grease weight of the fleeces of 36 American Merino ewes was 13.04 pounds. This was made up of 10.34 per cent moisture, 27.68 per cent grease, 27.01 per cent dirt, and 35.26 per



Courtesy Ohio Agricultural Experiment Station

A cross-section magnification of Merino wool fibers shows differences not detected by the unaided eye: left, the fibers are mainly uniform in size; right, some fibers are more than three times the diameter of the smallest fibers.

cent clean wool. Thirty-three Tasmanian fleeces averaged 9.36 pounds. This weight was made up of moisture to the extent of 9.70 per cent; grease, 18.80 per cent; dirt, 19.34 per cent; and clean wool, 52.15 per cent. The clean wool is the only one of the four ingredients that make up the weight of the fleece as it comes from the sheep that has any considerable commercial value, although

some of the lanolin in the grease is sometimes salvaged. The average length of staple for the American sheep was 2.74 inches, and for the Tasmanians it was 3.17 inches. When touched and examined for density, both groups were considered to have approximately the same density, but when density determinations were made in the laboratory the Tasmanians possessed from 8,000 to 20,000 more wool fibers per square inch of skin area. Incidentally, the numbers of fibers per square inch ranged from 11,834 to 45,821.

Cross-section magnifications of wool fibers show many irregularities in size and shape, which it is impossible to detect when the fibers are examined by the eye. The illustration on page 121 shows a sample of two fleeces. In one of these the diameter of the largest fiber is more than three times the diameter of the smallest fiber. There are some differences in all fleeces, and while in this study the differences were greatest in the American Merinos, there were rather large differences in the fleeces of the Tasmanian sheep also.

In meat production the American Merinos were considerably superior to the sheep imported from Tasmania.

Characteristics. Since these various types of Merinos come from the same parent stock, they are, in general, much alike in some characteristics. All of these types are capable of producing lambs differing greatly from the type shown by the parents. "B" type rams and ewes may have lambs that have the characteristics of the three types. In fact, it is not unusual for twin lambs to be of two different types. There is, of course, a greater probability of getting "C" type lambs from the mating of two "C" type individuals than from the mating of rams and ewes of the "A" type.

In general, adult Merinos have strong constitutions and are able to exist where conditions are not especially favorable. They are hardy despite their general lack with respect to body features, which are generally thought of as being related to constitution. At birth the lambs, however, are not especially strong or able to withstand unfavorable conditions.

Most rams have horns, but there are some polled strains. The ewes are hornless as a rule, but there are some that have small horns or scurs. The horns of rams are angular at the base and form a large downward and forward curving spiral. The part of the face not covered with wool is covered with fine, white hair. The lips and nostrils are flesh-colored, although reddish brown or black spots are not uncommon on these parts, as well as close about the eyes.

The skin is pink. The wool extends over the face and legs, but the degree of covering varies. In some cases the covering on the face is so excessive as to cause wool blindness. Many producers of show sheep have favored the excessive covering, believing that heavy wool production was impossible without it. There is, in general, less emphasis upon face covering in the "C" type than in either of the other types.

Merino fleeces vary in length, in fineness, and in the amount of yolk. Practically all fleeces of good quality show a very close, even, distinct crimp. The number of crimp per inch of fiber may exceed twenty. While the finer-fibered fleeces may have the most crimp, there is no positive relationship, as some especially fine-wool shows a "robust" crimp which is less numerous per inch of fiber than the crimp of very small size. Recent developments in fiber analysis have shown that not all earlier statements about wool were true.

Distribution. Merinos as purebreds are found chiefly in Ohio and Texas. Elsewhere there are many grade flocks, but these are not so numerous as Rambouillets. At one time large numbers of Merinos were exported to Southern Hemisphere countries.

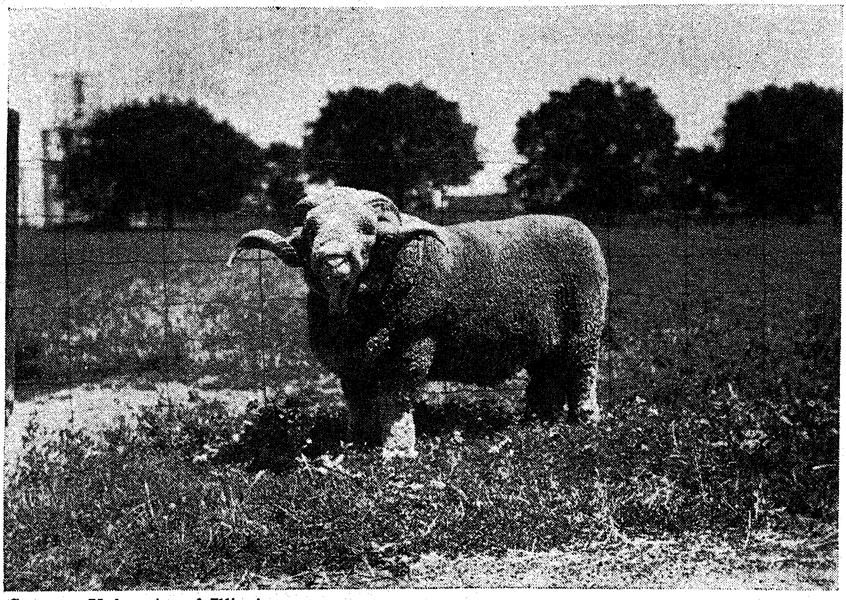
Registration. There have been many Merino breeders' associations, but most of them have had short periods of existence. At the present time The American and Delaine Merino Record Association, with headquarters at Xenia, Ohio, is considered as the successor of practically all other associations.

CHAPTER 19

★ *The Rambouillet* ★

Rambouillet sheep were developed after the Spanish Merino was introduced into France. While the name is French and the headquarters of the development were in France, a considerable part of the establishment of the breed took place in Germany. The history of the breed is one of the most complete and most fascinating of all breed histories. Since 1893, when Rambouillets became firmly established in the United States, they have been a factor of tremendous importance in the sheep industry. They became the dominant type in the great range-sheep industry but, in recent years, have declined in importance, as crossbred types in whose formation the Rambouillet and Merino played a part have become more prominent.

Rambouillets have been used for the two purposes of wool and meat production, but for a considerable period wool received the greater emphasis. The influence of the show ring was chiefly upon wool production, and the external appearance which was supposed to reflect body conformation was fashioned by the skilled hands of the men who fitted the animals for showing. Many Rambouillet breeders had been producers of Merinos and developed the Rambouillet along lines similar to the Merino types, with the exception that much greater emphasis was placed on size. Two types, "B" and "C," became the rule, and while an "A" type was never recognized by the breeders of the show ring, the type did exist in many flocks. The differences between the types was the same as in the case of the Merinos. Many breeders insisted upon commercial sheep raisers using the kind of sheep the breeders wanted to produce rather than trying to produce the kind the commercial men wanted because of the suitability of the products from the market standpoint. The result was a decline in popularity. In spite of this decline, the Rambouillet continues to hold an important place in the sheep industry. There is now a decided prefer-



Courtesy University of Illinois

The Rambouillet is a rugged, vigorous breed. This ram in short fleece shows unusually good body form. Less wool on the face and smaller neck folds would be favored by many breeders.

ence for smooth-skinned, large, heavily fleshed, and long, heavily fleeced sheep of this breed.

Size. Mature rams in good condition and in full fleece weigh from 225 to 275 pounds. Some rams of very large size and fitted for show have weighed as much as 375 pounds. Ewes weigh from 140 to 200 pounds. Thus it is evident that the Rambouillet is a breed of considerable size, but the size, as in other breeds, is influenced by environment.

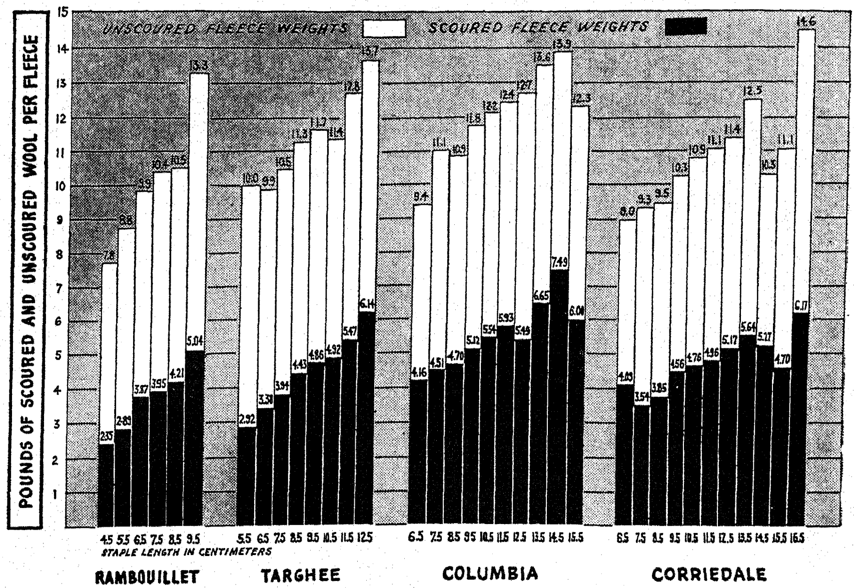
Form. Rambouillets are somewhat upstanding compared with the lower set medium-wool breeds. The general appearance is of a strong, vigorous, heavy-boned sheep with a style peculiarly fitted to the breed. The head is carried fairly high, and the actions are quick. Sheep which have any appearance of weakness would not be considered typical of the breed. The body shows evidence of reasonably good meat production because of its width, depth, and general fullness. While there are few Rambouillets that have the smoothness and fullness of body of many specimens of the

Courtesy U. S. Sheep Breeding Laboratory

This open-faced yearling ram has the freedom from wool blindness now demanded on the ranges.

medium-wool breeds, there are some that are remarkably good in these respects and show the possibilities of further development of the breed's meat production qualities. They are generally superior to the Merinos in conformation. Many Rambouillets that have heavy folds do not possess as good form as those of the smoother type. Skins free of wrinkles do not, however, assure sheep with good bodies, as there are many such that are uneven in top line, lacking in spring of rib, and in fullness of thighs and twist. Fleshing qualities would not be rated as high as in most of the medium-wool types, but some Rambouillets are superior in handling qualities of the back and loin. The legs are usually only fairly well set, but the bone is strong, and the Rambouillet is a good traveler.

Wool. Within recent years less emphasis has been placed on the fleece. Nevertheless, the Rambouillet is an excellent wool producer. The wool extends well over the body, and there is some wool on the legs below the knees and hocks as well as about the face. Most attention is now given to sheep with only a moderate covering on the face, and it is considered a serious fault if the covering is such as to result in wool blindness at any time. At one time some breeders sought so much wool on the faces that the usefulness of the breed was impaired, and its popularity suffered. Work at the



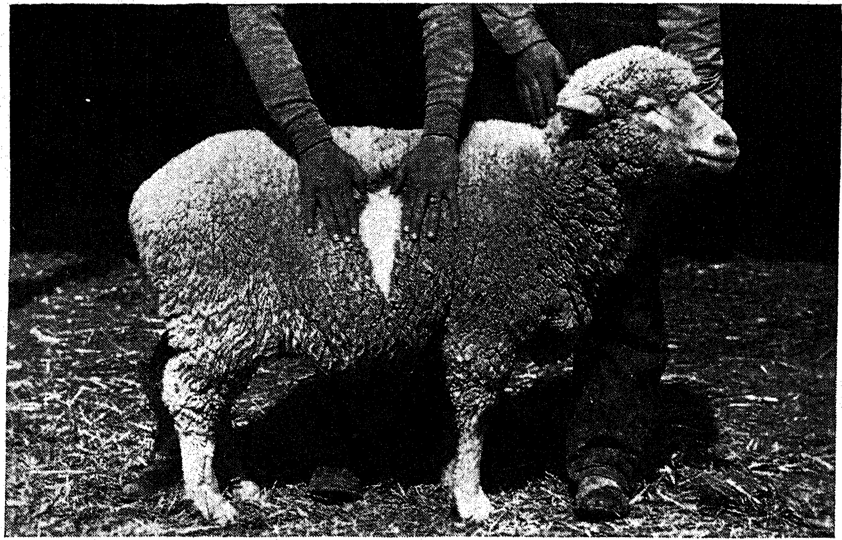
Courtesy U. S. Sheep Breeding Laboratory

This chart shows the relation between the length of staple and scoured and unscoured weights of fleece. Length of staple is important in obtaining good weights of both grease and clean wool from various breeds.

United States Sheep Breeding Laboratory at Dubois, Idaho,[1] showed that clean-faced ewes yielded lighter-shrinking fleeces with a higher content of wool fiber than the fleeces from extremely woolly-faced sheep. Since there is no advantage whatever in woolly faces and since such sheep are far more difficult to handle than those with little or no wool on the face, the present effort is toward an emphasis on those factors which have been found to have some relation to good wool production.

In twelve months the fleeces of smooth-bodied sheep will attain lengths of from 2.3 to 3.0 inches or more. The average fleece length of the fleeces of 1,939 ewes at the government's station was 2.33 inches.[2] The wool has good uniformity of fineness, and most fleeces grade half blood or fine. The wool growth varies in density on individual sheep, but it is practically always sufficiently dense to afford good protection. Some density determinations have shown

[1] U.S.D.A. Tech. Bul. 85.
[2] U.S.D.A. Cir. 308. 1934.



Courtesy U. S. Sheep Breeding Laboratory

Smooth bodies, open faces, and long-staple wool are sought in Rambouillet ewes.

as many as 50,000 or more fibers per square inch of skin area, but the average density is considerably less. The grease content is usually less than in Merino wools, but loss of weight in washing varies widely depending upon the conditions under which the sheep have been kept.

Characteristics. Most rams have large spiral horns, but there are also polled Rambouillet rams. The horns, like those of the Merino, have transverse ridges which are sometimes considered as indicative of the fineness of the fleece, as there is some variation in the size and closeness of these horn "crimps." Horns with considerable spread from the side of the head are preferred. Ewes seldom have more than small stubs or scurs, and many of them are entirely hornless. The ears are medium in size and covered with white hair. The face is white, although brownish and black spots occur about the eyes, nostrils, and lips. While these are not sought, they are not particularly objectionable. The skin is almost invariably pink. The feet are white and are strong and tough.

The general appearance varies with the folds or wrinkles in the skin. Sheep free of folds are now preferred, as the lambs from

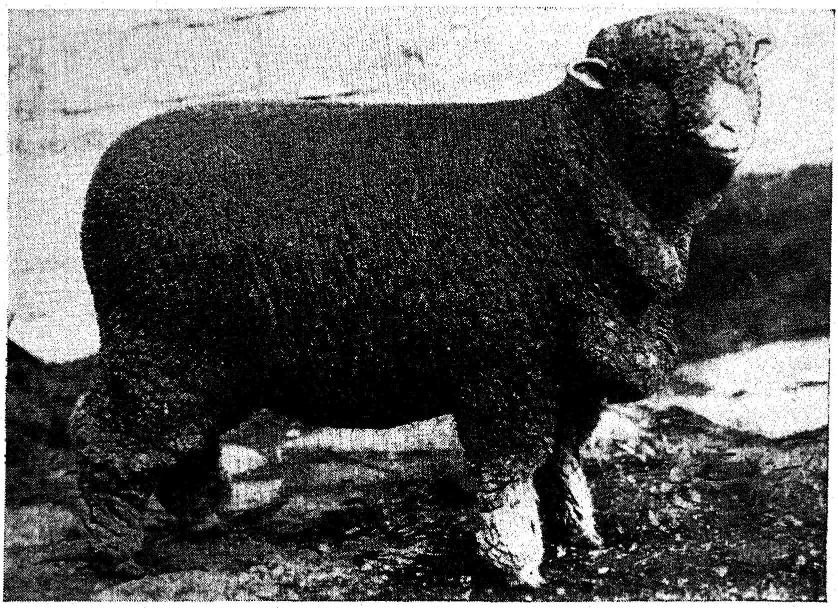
them are less severely criticized by feeders and slaughterers, and the wool of this type is longer and more uniform than that from animals with many folds.

Utility. Rambouillets are hardy and are apparently adapted to a wide range of climatic and soil conditions. They withstand high temperatures better than medium-wool types and yet do not show any lack of adaptation to cold regions. The dense fleeces shed heavy rains. Many sheep raisers are of the opinion that the useful life of the Rambouillet exceeds that of the medium-wool breeds.

Prolificacy in a small flock that is well handled may equal that of the best medium-wool breeds, but under range conditions the lambing percentage may be reduced. The ewes are good milkers if well fed, and the lambs are large at birth. Perhaps a weight of 8.5 or 9.0 pounds would be an average birth weight for single lambs. The ewes have strong tendencies to early breeding, and many of them are bred to drop their lambs in November and December. The lambs grow fast and carry a fair degree of fat at satisfactory market weights if they have good range or pasture. The lambs make good feeders, but the carcasses do not often have the plump, full shape of the medium-wool lambs. The fat covering is often not the best about the shoulders and lower thighs. Because of the heavier pelt, the dressing percentage is generally less than with the more definitely meat-type breeds. In the feed lots of the Central States, lambs make gains the equal of, or only slightly below, those made by other lambs. Wrinkly lambs, especially those that have folds around and below the dock, are more subject to fly-blow than are smooth-skinned lambs.

For crossing, Rambouillet ewes are extensively used. When bred to good medium-wool rams, they produce lambs that meet general requirements of all except the very fastidious markets. Millions of grade Rambouillet ewes on the ranges are bred to medium-wool rams, especially Hampshire and Suffolk, and produce lambs of good growing and killing qualities, coupled with the necessary constitution and herding instincts. Many farm flocks, too, are built on a Rambouillet ewe foundation.

Standard of excellence. For many years there was no scale of points by which those selecting purebred Rambouillets could be guided. It was commonly supposed that judges gave equal consideration to general body features and to wool. Several years ago the breeders' association approved the following score card as a



Courtesy University of Illinois

Rambouillet breeders are placing great stress on improved meat quality, length of staple, and freedom from folds in the skin.

guide. In it fleece characteristics are given only slightly more than half as much emphasis as is now placed on body. This reflects the change in the relative importance of lambs and wool as items from which the returns from a sheep enterprise are obtained. Two types are recognized, but the "C" type is considered the standard of the breed, and judges should discriminate against the "B" type when shown against the "C" type. The "C" type is the better dual-purpose sheep, and wool and mutton are obtained in greater degree from it than from the "B" type. The "B" type may carry few or many folds, and the fleece may be short (2½ inches in twelve months is a basis) and very dense. The "C" type must be free of wrinkles of any sort, although a small dewlap or apron is permissible, but neck wrinkles must not extend more than halfway upward toward the top of the neck. The fleece is long (3½ inches or more in twelve months) but not too open. Although some matters in the score card are not subject to a single definite interpretation, the main points are clear. The standard given here has been slightly

modified in extent, compared with the original prepared by the breeders' association.

BODY	66
General appearance and breeding. Stylish, active; free from body folds or wrinkles; symmetrical. Desirable mutton conformation; rams strongly masculine; ewes distinctly feminine; plenty of development (age considered)	15
Head. Ram strongly masculine. Ewe distinctly feminine. Medium length; forehead, broad; wide between ears	2
Face. Silky hair free from coarse chalk hair or kemp; broad nose in rams; well-developed muzzle; lips thick, pink in color, and free from dark spots; nostrils large; under- or over-shot jaw disqualifies the individual	7
Horns. (Horned strains of rams) well developed, with distinct corrugations; horns wide at base; wide spread from neck or jaws. In polled strain, absence of scurs or knobs desirable	2
Eyes. Large, alert, prominently set; rolled-in eyelids and lashes objectionable. Eye area free from wool to insure good vision	3
Ears. Broad, thick, and relatively short; velvet or silk-like covering	1
Neck. Medium to short length; smooth; blending neatly with head and shoulders; only apron or dewlap extending from shoulder to shoulder in front of brisket	3
Chest. Deep and broad; good width between front legs	6
Withers. Fairly well rounded; not too far apart or too prominent	1
Top-line. Straight with no drop in front of or behind withers, and well carried out at rump	4
Back. Medium length, fairly broad, loin wide, blending smoothly with hips	5
Ribs. Well sprung and preferable well rounded out	2
Rump. Long, wide, and level, carrying width to dock; tail head smooth—free from folds	2
Leg of mutton. Well filled out, twist deep, free from medial folds	2
Scrotum. Two normally developed testicles; ridgling character disqualifies. Udder, sound and well developed	1

Legs. Medium length, straight, strong, white, pasterns strong; hoofs amber color; legs well apart	10	
FLEECE		34
General appearance. Attractive, even; dense, high-yielding staple wool (12-mo. basis); light to medium covering on face; open face very desirable; forehead covered but no wool around eyes to obstruct vision; wool covering on legs nearly to hoofs; free from objectionable fibers	4	
Length of staple. (12-mo. basis). Approximately uniform length over body, including belly covering; minimum area in flanks and armpits uncovered; should be staple length ($3\frac{1}{2}$ inches or more when fed for show purposes)	12	
Fineness and evenness. Well-defined, even crimp extending from base to tip with uniform diameter; soft and pliable; bright, attractive color; sound throughout; free from kemp and off-colored or other undesirable fibers; fineness in rams 60's to 64's, in ewes 64's to 70's	6	
Density of covering. Even, or slightly wavy tip; (a too open fleece is indicated by open, ropy locks with dirt, sand, and other foreign particles penetrating almost to the skin along the top-line, and also large uncovered area in flanks and armpits); belly wool with medium density and good staple length appears to be reliable indicator of density and high-yielding qualities	8	
Condition. Yolk moderate, preferably light to creamy in color, evenly distributed; heavy, dark, clotted yolk objectionable; minimum of sand, dirt, vegetable matter, and stained locks	4	
TOTAL		100

Distribution. There are breeders of purebred Rambouillets in twenty-seven states, but most of them are in the western states. In fact, most of the breeders who are members of the breeders' association are in Texas. This distribution of the producers of purebred Rambouillets is indicative too of the general distribution of grades. Most of these grade sheep are in Texas, but there are liberal numbers in many other states. Possibly half of the sheep in the United States carry Rambouillet blood. Many Rambouillets

have been exported to countries in South America and elsewhere during the past twenty-five years.

Registration. The American Rambouillet Sheep Breeders' Association was organized in 1889. Its headquarters are at San Angelo, Texas, now. At the close of 1945, approximately 475,000 head had been recorded by the organization. No volumes of registrations have been issued for many years, but the association does distribute promotional literature.

CHAPTER 20

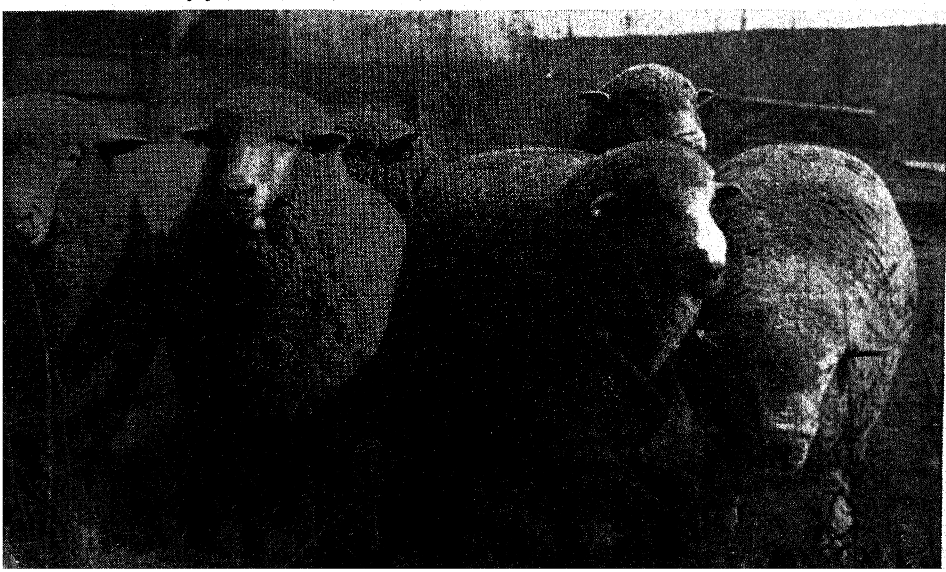
New and Minor Breeds

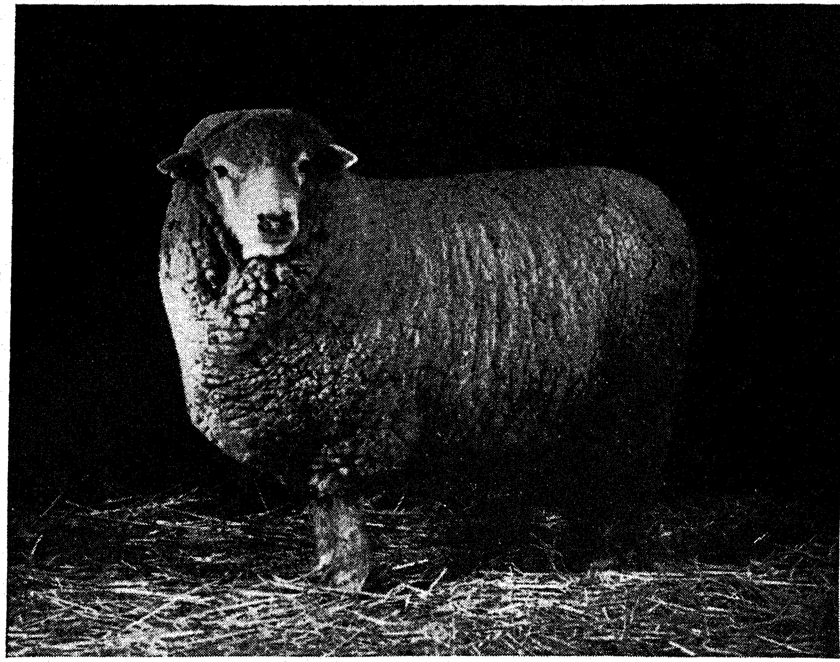
The new and minor breeds include the Panama, Romeldale, Southdale, Tailless, Tunis, Black-faced Highland, Ryeland, and Targhee. The first four and last of the breeds listed are the result of crossing existing breeds or types for the formation of new ones. Those given are more or less typical representative results of efforts to create new breeds, but there are many other efforts directed toward selection of strains or toward combining types and breeds already established. Some of these may attain considerable importance in the future if they are found especially suitable for commercial requirements.

The Panama. The Panama resembles the Columbia closely

These Panama rams show the general characteristics of the breed.

Courtesy James Laidlaw, Muldoon, Idaho, and Denver Record Stockman





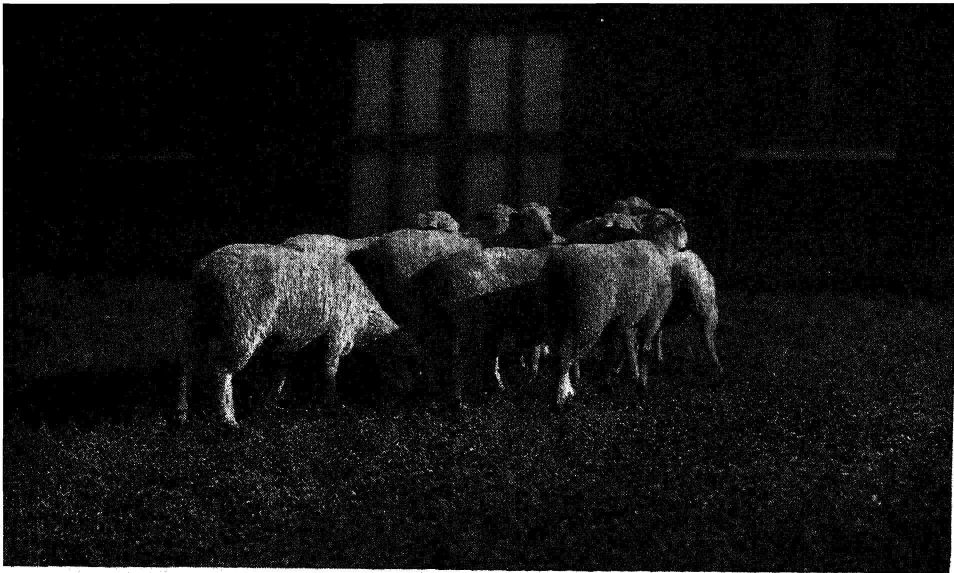
Courtesy A. T. Spencer and Son, Gerber, California

The Romeldale is the result of another effort to blend into one breed desirable features possessed by two breeds.

in all respects. This would be expected as it was produced by the use of Rambouillet rams mated with Lincoln ewes. The Lincoln rams and the Rambouillet ewes were used in the establishment of the Columbia. The Panama was developed in Idaho. There is no organization of breeders.

The Romeldale. The Romeldale resulted from the crossing of Romney rams and Rambouillet ewes. Most of the Romeldales are found in California where the development took place. They are smaller than Columbias and have slightly finer fleeces. There is no breeders' organization.

The Southdale. The Southdale represents a cross of the Southdown and the Corriedale. This development was undertaken by the United States Department of Agriculture in an effort to evolve a sheep that had better fleece qualities than the Southdown and better meat qualities than the Corriedale. The results secured up to the present indicate that such a cross can be made successfully,



Courtesy South Dakota State College

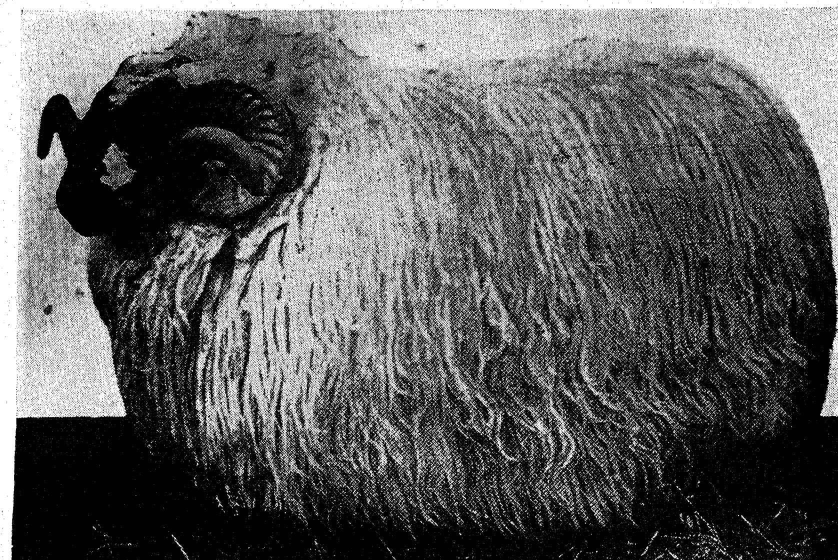
These are representative sheep of the "no tail" breed. The best specimens compare favorably with some of the representatives of older breeds.

but neither the field of usefulness nor a definite type has been fully established.

The tailless or "no tail." The tailless, or "no tail," sheep of an improved type have been developed by the South Dakota Experiment Station.[1] The purpose was, of course, to eliminate the necessity of docking, or removing the tails, of lambs, which is an established practice with all other breeds. The work was started in 1914, following the importation of some fat-rumped sheep with very short or no tails from Siberia. The work has required a good deal of time as the tailless characteristic is not dominant in crossing, and it was necessary to cross the Siberian sheep with improved breeds in order to eliminate the undesirable features but propagate sheep without tails. Practically all of the early attention had to be given to getting the tailless feature without regard to other matters. More recently, an effort toward improvement in the form and fleece characteristics has been made, as sufficient numbers of "no-tail" animals have been bred to warrant such selection.

Tunis sheep. The Tunis sheep have been produced in this country for many years, but they do not possess features that are desired by many sheep raisers. There are flocks in several states.

[1] So. Dak. Exp. Sta. Cir. 28.

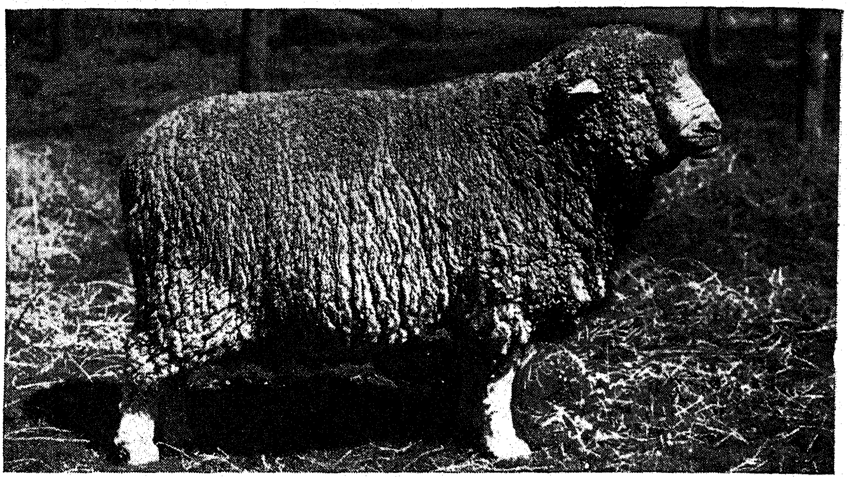


Courtesy J. A. Telfer, Department of Agriculture, Ottawa, Canada

The Black-faced Highland is a small hardy breed. A blotched face is not unusual.

This is a medium-sized breed with brownish faces and rather coarse wool, which often is criticized because of the presence of black fibers. There is some tendency for excessive fat about the dock. The Tunis is hardy, the ewes are good mothers, and the lambs make reasonable growth. The progress of the breed has been slow because it does not meet conditions as satisfactorily as do other breeds.

The Black-faced Highland. The Black-faced Highland is one of the hardiest breeds brought to the United States and Canada. There are only a few of them in this country, as they are relatively unimproved, especially with respect to the finer aspects of wool production. They have a long, coarse outer coat and a finer undercoat of wool, which together afford a maximum of protection against the inclement weather of their native home, the highlands of Scotland. They are a small, short-bodied, muscular sheep with light, high shoulders and are adapted to travelling over rough terrain while gathering their food. There is no wool on the face or legs, which are black or mottled. The rams have fairly large, spirally curved horns, and the ewes have small, short horns which are



Courtesy U. S. Sheep Breeding Laboratory

The Targhee is similar in foundation to the Columbia but shows the greater influence of the Rambouillet in the quality of its fleece.

curved but do not form spirals. This breed is said to yield deliciously flavored meat of the highest quality from the feeds found on the high altitudes, to which they seem particularly adapted.

The Ryeland. A few Ryelands were imported to this country some years ago (1928), but they have not been widely regarded as of special importance. They have been used to a fair degree in parts of Australia and New Zealand. They originated in Herefordshire, England. They resemble Shropshires in some respects and have sometimes been called white-faced Shropshires. They have grayish white faces.

The Targhee. The Targhee has been developed since 1926 at the United States Department of Agriculture Sheep Experiment Station, Dubois, Idaho, through a foundation made by mating select Rambouillet rams with select ewes of Lincoln-Rambouillet breeding or of ewes that resulted from crossing Corriedales and Lincoln-Rambouillets. The rams and ewes of such matings have been interbred on the basis of production performance under range conditions. The Targhee is a white-faced, polled breed of intermediate size. It is clean-faced, free of skin folds, and has a fleece of half-blood quality of about three-inch staple. The yearly fleece weight per ewe is approximately 11 pounds of grease wool with a shrinkage of about 55 per cent. The range-raised lambs average about 80 pounds when 140 days of age.

CHAPTER 21

The Karakul

Karakul sheep have many peculiarities not found in the other types of sheep in this country. At birth and for a very few days thereafter, the lamb pelts are of a character that makes them suitable for use as furs. In fact, the Karakul is often spoken of as a fur-bearing sheep. While this may be true of the lambs, it is far from true with respect to the pelts of the older animals. This property of the lamb pelts and the hardiness of the sheep are the two most useful features. From the standpoint of meat and wool qualities the Karakul must be given a low rating. They were introduced into this country about forty years ago. The importations were small in numbers, and while there are flocks in many sections, the numbers of pure Karakuls are now few. These sheep may be raised in any section where other types of sheep are produced, but whether they can be profitably raised depends largely upon the price received for the pelts. Most profits to date have come from the sale of breeding stock for the establishment of flocks rather than from pelt sales.

Size. Mature rams weigh from 175 to 225 pounds. Ewes range from 135 to 160 pounds. Since these are weights of mature sheep, the breed is rated as of medium size.

Form. The Karakul is lacking in many respects when compared with the better meat-type breeds. The body tends to be narrow and uneven; the neck is long; the loin is high; the spring of ribs is poor; the leg lacks fullness; and the rump is steep with an overhanging mass of fat. This is detrimental to breeding of the ewes and is certainly not desired in market animals.

Wool. Karakul wool is of very low quality. It is coarse and wiry and is brown or black. There are two types of fibers in the fleece; the long outer coat is from 6 to 10 inches long, very coarse, and may be grayish brown or black, while the shorter undercoat is finer and usually dark brown or black. The wool grades as carpet

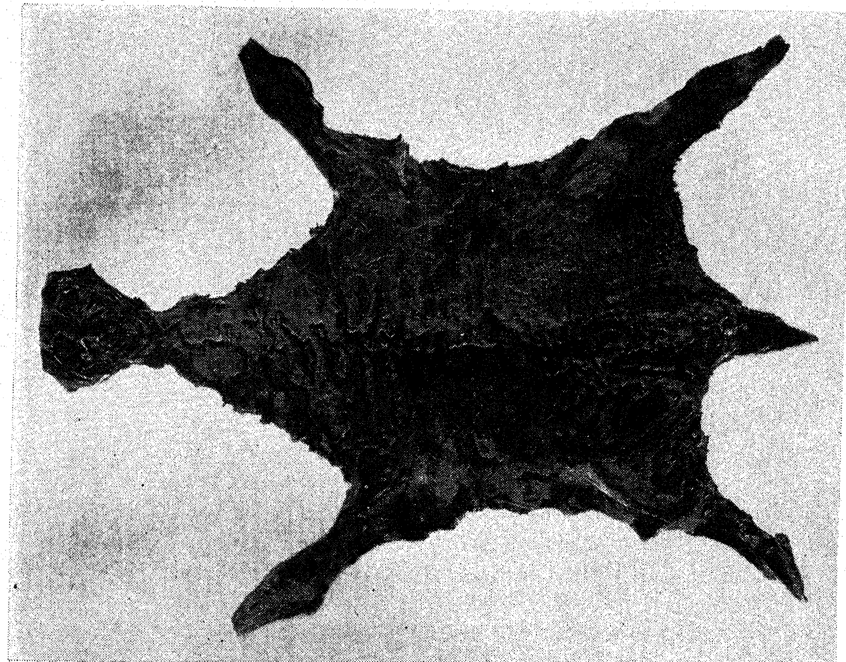
Courtesy D. A. Spencer, Agricultural Research Administration, U.S.D.A.

This Karakul ram of good type shows the coarse, wavy fleece typical of the Karakul except as young lambs.

wool and sells at a discount of 30 to 50 per cent, compared with wool of other classes. Fleeces weigh from six to eight pounds. The fleeces of 455 purebred Karakuls shorn during the years 1929–1940 in the flock of the United States Department of Agriculture had an average weight of 6.3 pounds with an extreme range of 1.7 to 14.3 pounds per fleece.[1]

Pelts. The pelts taken from lambs are usually classified as Broadtail, Persian Lamb, Krimmer or Crimean Lamb, and Caracul. Within each of these groups there are different grades of pelts, depending upon quality, tightness of curl, luster, pattern, color, and general appearance. Broadtail pelts are usually obtained from lambs that are born a few days prematurely or that are killed within a very few hours after birth. These have a characteristic broad waviness or so-called "watery" design. Persian Lamb has a short, tight, close curl. Most of these are black. When gray in color they are called gray Persian Lamb or Krimmer. A type, apparently less common now than formerly, that had a more open curl than the Per-

[1] Karakul Sheep. U.S.D.A. An. Husb. Div. No. 38. 1941.



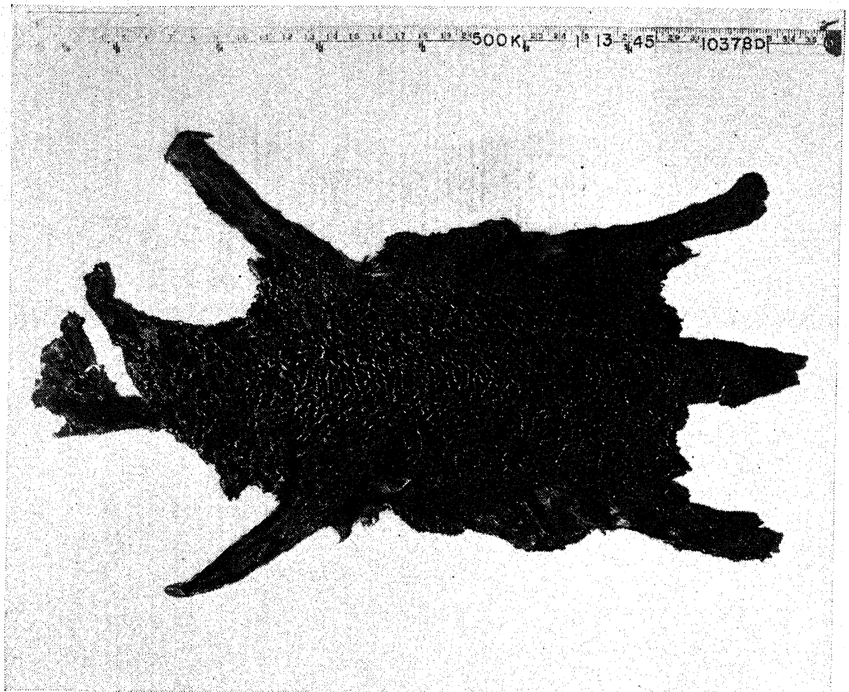
Courtesy D. A. Spencer, Agricultural Research Administration, U.S.D.A.

Because it is very lustrous and lightweight, the "broad tail" is the most valuable type of pelt.

sian Lamb was called Astrakan; Caracul is an open, lustrous type of pelt.

Mouton furs are not obtained from Karakuls but are a processed fur made from pelts of the usual types of sheep. These are dyed and processed into imitations of many different types of furs.

Many millions of Karakul pelts are imported. Their values vary greatly, and the general prosperity of the nation has a significant influence on prices. It is difficult to sell small numbers of pelts to advantage because to make high-quality garments a large selection is needed so that the pelts used in one garment may be perfectly matched. Imported skins sell from $3.00 to as much as $15.00 or $20.00 each. The domestic skins have sold from 50 cents to $12.00. The average raw-pelt value of 128 skins from purebred Karakul lambs from the flock of the United States Department of Agriculture during the years 1939–1940 was $4.38. Many pelts from grade lambs are less valuable than pelts from purebred lambs.

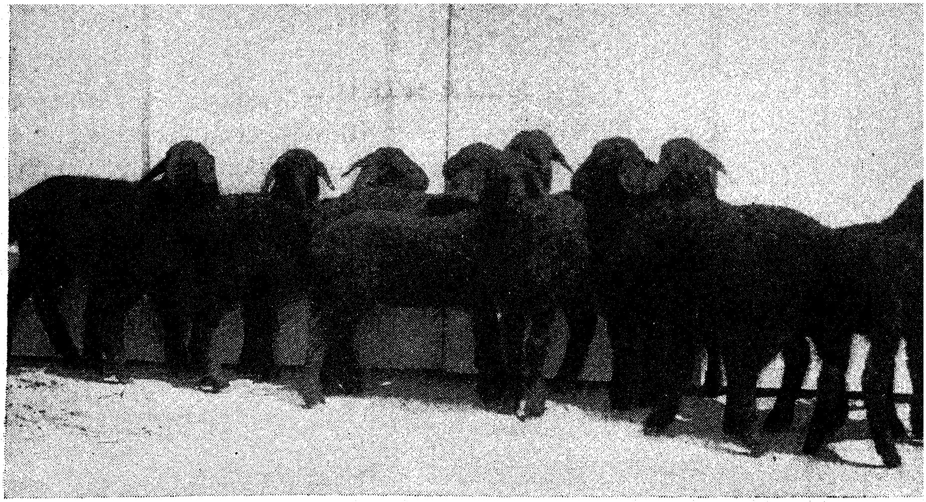


Courtesy D. A. Spencer, Agricultural Research Administration, U.S.D.A.

Persian lamb has more numerous but more open curls than broad tail. The value of Persian lamb depends largely on pattern uniformity and lustre.

Characteristics. The Karakul is black- or brown-faced. Rams may have horns, but the ewes are hornless. The wool extends to the back of the ears and to the knees and hocks. The ears tend to droop. The profile is arched in rams, and there is sometimes a slight arch in ewes. The skin is dark. The heavy fat accumulation at the dock is found in many other Asiatic sheep.

Utility. The main usefulness of the Karakul is the production of pelts. Aside from this feature and its hardiness, the breed possesses nothing not found to a more desirable degree in other breeds. Many sheep sold in this country have been grades produced by mating Karakul rams to various types of ewes. Experimental work has shown that several generations of crossing is needed to produce pelts of reasonably good quality. Ewes having at least 50 per cent long-wool breeding are most satisfactory as foundation ewes for such grading up for the production of pelts. Even in pure-



Courtesy D. A. Spencer, Agricultural Research Administration, U.S.D.A.

There are relatively few pure Karakuls in this country. These are three-fourths Karakul ewe lambs. Their curl is too loose for good furs.

bred Karakuls there is much variation in the quality of pelts, and there is not now any reliable means of estimating the kind of pelts that mature animals will produce on their lambs.

The lambs are good sized at birth. The ewes are good milk producers but are not highly prolific, as twins are not often dropped. As an average, Karakuls may be expected to live a year or two longer than medium-wool breeds. Claims that the meat of the lambs has exceptional goodness are not founded on fact, and on the markets sales are at a considerable discount.

Distribution. Flocks are not numerous in any section of the United States. The breed is actively promoted, but the high prices asked for breeding animals make it impossible to obtain a profit except through the further production and sale of breeding stock. The industry must, however, be built on a production basis, and this cannot be done except through reduced prices for breeding animals. Many flocks have been established and dispersed within a very few years.

Experiment stations working with Karakuls have found that one of the chief problems to be solved in putting the industry on a sound basis is improvement in breeding stock to reduce the variation in the types of skins and assure a high proportion of the more valuable pelts. This can only be accomplished through the most rigid selection and the keeping of accurate records and the discontinuance of promotion on the basis of propaganda. Another difficulty relates to the development of a market for small lots of pelts

and in the extension of knowledge with respect to the handling of the pelts between the time of removal and marketing. The Karakul business is one of considerably more specialization than the usual type of sheep raising. The Texas Station reports that from a purely business standpoint the Karakul does not seem to offer as much profit as other breeds in regions where the other breeds will thrive.

Registration. A national association known as the Karakul Fur Sheep Registry, Friendship, Wisconsin, records sheep of this breed.

CHAPTER 22

★ *Judging, Selecting, and Classifying Sheep* ★

Judging, as a phase of sheep husbandry, is an effort to appraise the degree to which an animal possesses certain characteristics that are considered essential if it is to be useful for a particular purpose. In a narrow sense judging is a term used in reference to the awarding of prizes at shows or to the placing of animals in order of merit in a classroom or in a contest. However, in this text judging is not considered in a restricted sense but refers to all aspects of selection or classifying for any purpose. The standard formalized judging of the show ring, which entails the rating or placing of animals on the basis of an approved standard combined with the interpretation of the standard by the judge, is a minor phase of the estimating of values and relative merits which comprises a fundamental part of the sheep industry. Judging or selection is never an end in itself. The purpose for which the selection was made must be accomplished for the judging to have value. Whether that purpose is accomplished depends upon many matters besides selection, and hence judging can provide only part of the information needed in any endeavor in sheep husbandry.

It is assumed that the student is acquainted with the elementary phases of judging, such as the identification of the external parts of a sheep, which of these parts constitute items of major importance, and which ones are minor considerations.[1] It is assumed too that the student is familiar with the generally accepted description of the ideal animal and the more or less standard methods for inspecting and examining sheep and for the giving of formal reasons explaining why one animal is placed first, another second, another third, and still another in last place in the rings of four which comprise many groups used in classrooms or in contests held in

[1] Elements of Live Stock Judging. W. W. Smith.

connection with some of the larger livestock shows. Consideration here is directed more toward the judging or selection necessary in connection with marketing, feeding, and breeding operations as these are carried on on farms, ranches, feed lots, and on the markets. In such considerations numbers involved are apt to be much larger than those used in most classrooms, although there may be times, as when a sire is being chosen, when all consideration is directed toward the valuation of only one animal.

Judging or selection, to be of any value, must be based on facts. It is the purpose of the inspection and observation of the animals to reveal information relating to their characteristics and thus provide a basis for an appraisal. The interpretation of the facts gathered by means of such inspection and examination and the emphasis placed on the various parts of the information will not be the same when done by different people. Such differences lead to variations in appraised values or estimates of relative merit. These differences constitute the basis for most of the "asking and bid prices" on the livestock markets or at other trading places.

General classes of sheep. There is no possibility of judging or selection unless it is first known what kind of sheep is to be selected. The general classes of sheep are lambs, ewes, wethers, and rams. The differentiation among these is standardized and widely accepted. The basis of separation among ewes, wethers, and rams is sex, while age serves as the basis for separation of lambs from the other groups. The lamb group is further designated on the basis of sex into ewe, wether, and ram lambs. The lamb group is, also, sometimes more definitely designated on the basis of age, origin, or weight into still smaller groups. The other classes of sheep may also be more definitely designated by separation on the basis of age, origin, color of face, and weight. In addition to such differentiations, the sheep may be used for different purposes. Thus, lambs may be slaughtered whether they are fat or thin. But thin lambs may be used for feeding purposes first and later slaughtered. Ewes might be selected first for breeding and then afterwards selected and appraised for slaughter. A summary tabulation of these classes of sheep is shown in the outline on page 147. While these classifications are usually considered as Market Classes and Grades of Lambs and Sheep, the classification does not of necessity involve a market transaction. A producer might have a group of full-mouthed, western, crossbred, white-faced breeding ewes on his farm. If they were

sent to market they would be the same, although they might be purchased as slaughter ewes, as feeding ewes, or as breeding ewes. It is not likely that they would have equal suitability for all three purposes, however.

OUTLINE OF MARKET CLASSES AND GRADES OF LAMBS AND SHEEP

Market offerings consist of (Class)	Further described according to age, origin, et cetera	Used for (Subclass)	Graded according to suitability for purpose	Described according to weight in lbs. as:
Lambs	Hothouse Spring Lambs Fed Native Western Black-faced White-faced	Slaughter (wether, ewe, ram)	Prime Choice Good Medium (fair) Plain (common) Cull	Light weight 70 down Handy weight 70–80 Medium weight 80–90 Heavy weight 90 up
	Western Native Texas Fine-wool Crossbred	Feeder (wether, ewe)	Fancy Choice Good Medium (fair) Plain (common) Inferior	Light weight 60 down Medium weight 60–70 Heavy weight 70 up
		Shearer	Choice Good Medium	
Ewes	Native Western Grade Crossbred Purebred Yearlings Two-year-olds Full-mouthed Broken-mouthed Gummers	Slaughter Feeder Breeding	Same as slaughter lambs Same as feeder lambs	*Yearlings* Light weight 90 down Medium weight 90–100 Heavy weight 100 up *Mature* Light weight 100 down Handy weight 100–120 Medium weight 120–140 Heavy weight 140 up
Wethers	Western Texas Yearling Two-year-olds	Slaughter Feeder	Same as lambs	*Yearlings* Light weight 90 down Handy weight 90–100 Medium weight 100–110 Heavy weight 110 up Approximately 10 lbs. more for mature wethers
Bucks (rams) Stags		Slaughter Breeding	Choice Good Medium Plain Cull	None

Explanation of terms. Many of the terms in the tabulation are self-explanatory, but others require some definition.

Hothouse lambs. Hothouse lambs are generally raised by confinement with their dams to sheds or lots and marketed from

December to April, usually at from 6 to 10 weeks of age and at weights of 30 to 60 pounds. They are seldom found on the open markets, as most of them are sold as dressed carcasses direct to consumers or through wholesale houses in large cities. Most of the hothouse-lamb business is conducted in the eastern states.

Spring lambs. Spring lambs are the first of any year's crop to reach the market in the spring of the year. The first spring lambs marketed are usually from the southwestern states or from California. The use of the term "spring" is discontinued about July first. Prior to that time "spring" serves to distinguish the new crop of lambs from those of the previous year that are being sold at the same time. After about July first, spring lambs become lambs, and those previously designated as lambs are yearlings (wethers) or yearling ewes. The term "aged" lambs is sometimes used to distinguish old from new crop lambs.

Fed lambs. Fed lambs are those which have been given grain in contrast with those direct off range or pasture. The fed-lamb season is usually from December to May.

Native and western lambs. Native and western are area distinctions, natives being from the farm states in contrast with westerns from the range states. There are usually rather distinct differences, although if the lambs from the two areas represent similar breeding the differences may not be pronounced. Lambs from Texas as well as those from other states are often designated by the name of the state.

Black-faced and white-faced lambs. Black-faced and white-faced are terms which are at least partially descriptive of the breeding of the lambs or sheep. Most black-faced range lambs carry some Hampshire or Suffolk blood. Native black-faced lambs also may be of Hampshire or Suffolk breeding or may be representative of such other dark-faced breeds as the Shropshire, Oxford, or Southdown.

White-faced sheep are either of fine-wool breeding or are crossbred animals resulting from the mating of two white-faced breeds.

Fine-wool sheep. Fine-wool sheep are either of Rambouillet or Merino breeding. They do not represent at the present time such satisfactory development of meat qualities as generally found in the coarser wool types.

Crossbreds. Crossbreds represent the product obtained by crossing two breeds or types. In general, grades resemble the type of sheep or lamb obtained through the continued use of one breed

of rams for several generations. Purebreds are supposed to represent a strain or variety with rather definitely established characteristics. They may be registered in an association's records or be nonregistered.

In the case of ewes, the term "full-mouthed" means that the eight incisor teeth possessed when the animal was a lamb have been replaced by "permanent" teeth. Since the teeth are not permanent, a better designation is adult teeth. "Broken-mouthed" means that some of the adult teeth have been lost, and "gummer" refers to sheep that have lost all of their incisor teeth.

Purpose for which selected. The purpose for which any individual or group of sheep or lambs is selected is always an important consideration. The usual purposes are slaughter, breeding, or feeding. Some lambs are selected for shearing purposes. After they are shorn, they may be offered for some other purpose such as for slaughter. Obviously, some kinds of sheep are of no value whatever for some purposes, and not all within a group are equally valuable for any specific purpose. A lamb highly desirable for slaughter would be of low value for feeding, for it would already possess the features which feeding would be expected to provide. The reverse statement would be equally valid in many cases. Wether and ewe lambs are considered more useful than ram lambs for slaughter and feeding because after an age of several months most ram lambs tend to develop proportionately heavier forequarters than are found in the others. Although the opinion is not always substantiated in tests, the meat of ram lambs is generally considered less palatable and less tender than the meat of wether and ewe lambs.

Because of their restlessness while in the feed lot and smaller value when fattened, ram lambs are seldom considered satisfactory for feeder purposes. They sometimes make larger gains in weight, despite their tendency to greater activity, than wether lambs, but feeders would insist on buying them at low prices compared with wether or ewe lambs.

Grade. As a convenience in expressing the desirability of sheep or lambs for a specific purpose, certain terms are used. These terms refer to the degree of suitability of the individual or group for the purpose for which selected. Thus, in the case of lambs selected for slaughter, the very best ones would be graded as prime. Prime lambs would possess all of the features needed to make them highly desirable from the standpoint of the butcher and the con-

Courtesy University of Illinois

There is little about these choice-prime, lightweight slaughter lambs which could be criticized.

sumer. They would be fat and would yield a high percentage of carcass based on their live weights. The carcass would meet all of the demands of the consumer with respect to palatability, tenderness, juiciness, and other factors he might desire.

If the lamb lacked in minor respects, it would be graded as a choice slaughter lamb rather than as a prime one. As the deficiencies became more evident, the grade would be lowered until the lowest grade, that of cull, was reached. The full list of grades which might be given to lambs selected for slaughter would be prime, choice, good, medium (fair), plain (common), and cull. In the case of lambs selected for feeding, the highest grade is fancy and the lowest grade is inferior. Breeding sheep are graded similarly to those selected for feeding purposes.

Determining grade for slaughter. Form, quality, and condition are the considerations in the determination of the grade of slaughter lambs and sheep. Of these, quality is the least subject to change, although some items which relate to quality may be changed along with the form and condition of the animals.

Good form is displayed when there is heavy development in the back, loin, and leg. No animal can be said to have good form, if it is narrow or shallow in the body or does not have a general

Courtesy University of Illinois

These cull lambs are thin and poorly developed. Between these and prime lambs are found the other grades of slaughter lambs.

fullness and smoothness of outline with thick, heavy fleshing. Since the back, loin, and leg are the most important parts of the carcass, any deficiencies in these regions bring especially severe criticisms. Extreme compactness and extreme shortness of legs are not requisites of good form if the body is especially well developed in other respects. Minor deficiencies in form, particularly in the regions of the body from which the cheaper cuts of meat are obtained, are of no great consequence in the determination of grade.

Quality. Quality is the evidence of excellence with respect to the kinds of materials which make up the lamb or sheep. In a sense quality is refinement, but it is possible for sheep to be too refined in structure. No specimen would be considered as showing a high degree of quality if there was any suggestion of coarseness about it. Quality is therefore shown by a freedom from those things which suggest coarseness or unattractiveness. Lambs and sheep have good quality when they have medium-sized, clean bone, head, and ears, and a full-rounded outline with a light pelt. A heavy pelt may not be coarse, but since it will reduce the dressing percentage, it is considered as an item of quality. Shearing a lamb would reduce the weight of the pelt, but this would not change the quality.

In addition to this general quality, there is the matter of qual-

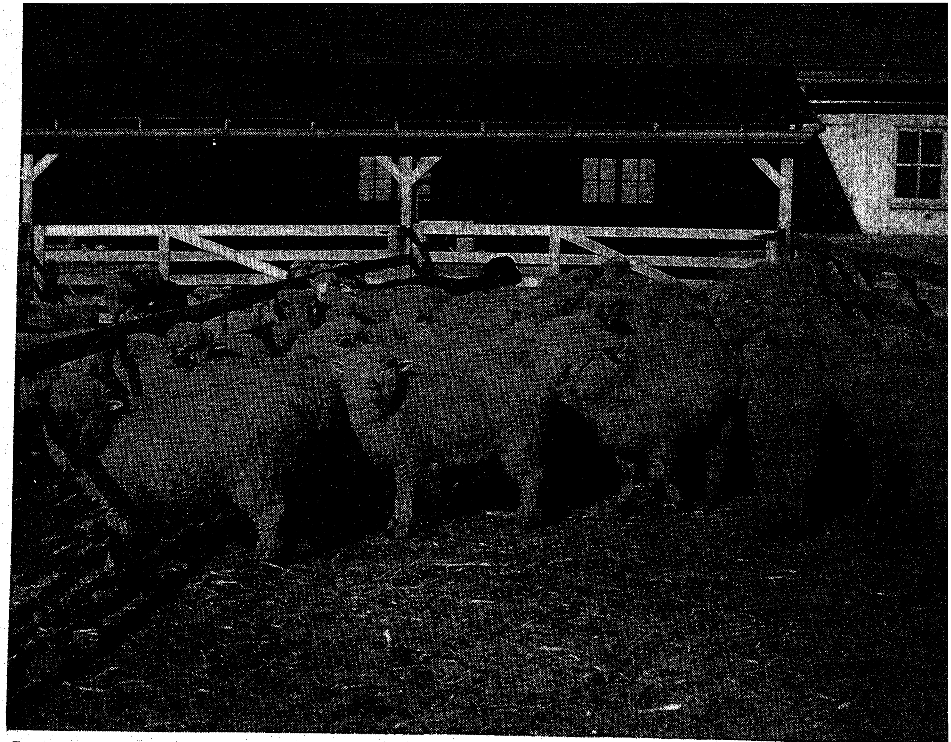
ity of fleshing. This is dependent to a great extent upon the condition, for a thin lamb would never be thought of as having a desirable quality of flesh. It is also possible for a sheep to be overly fat —the condition is seldom found in lambs—and thus be given a low rating with respect to quality of flesh. A smooth, even, firm covering of fat is desirable. The character of this covering is determined by handling the lambs along the back, ribs, loin, rump, and twist.

Condition. A good covering of fat is desirable, for this will give a good dressing percentage, will make the carcass more attractive, will improve its keeping qualities and reduce the losses during refrigeration, and will cause the meat to have greater palatability, as it will be more juicy and tender. The amount of condition is determined by handling in the same regions of the body as given above under quality. However, anyone with experience can avoid detailed handling to determine the general condition of lambs by merely spreading the thumb and hand so that the back and ribs are touched.

Market men may handle the docks for thickness and covering, too, in one stroke. In deciding between two or more animals, to give as exact an appraisal as possible between them, more detailed handling would be required. For detailed directions for such handling, texts on judging should be consulted.

In the grading of market lambs, condition is the most important of these three factors. It is the most subject to change of any of these matters. No matter how good the lamb may be in form and quality, it cannot be considered as a prime lamb if it is not fat. On the other hand, if it is fat, it may have small deficiencies in form or quality and still be considered as highly satisfactory. While fat cannot be added to the body without changing the shape of the body, it is the presence of the fat rather than its effect on form that is important. Fat animals always have better form than the same animals when thin, but there are great differences in the form of thin as well as of fat lambs and sheep.

Determining grade for feeding. In appraising the suitability of lambs or sheep for feeding, these three factors—form, quality, and condition—do not cover all of the items of importance. Indications of satisfactory feed-lot performance rather than killing qualities must be sought. The viewpoint is greatly different in the two cases. In the case of slaughter lambs the grade is an immediate consideration, while in the case of the feeder lamb the emphasis is



Courtesy University of Illinois

These are choice-grade, black-faced feeder lambs. When lambs of this general quality and conformation have been fattened, they fulfill requirements for choice-grade slaughter lambs.

upon the present grade in relation to the grade the lamb will attain in the future. Top-grade feeder lambs would be expected to develop into top-grade slaughter lambs with little difficulty. If there was any question about their doing so, they could not be classed as choice or fancy selected feeders. Lower-grade feeders would have some attributes which suggested to the appraiser that they might be lacking in ability to perform well in the feed lot or to finish into the most desirable kind of fat lambs.

Thus, considerations in the assignment of grades to feeder lambs would involve not only form, quality, and condition, but such matters as health and constitution, substance, and fleece. Without good health and constitution, lambs would not have appetites and abilities to consume large amounts of feeds and make rapid and economical gains. Neither would there be evidence that they would be able to survive under the conditions of feeding. Substance in the bony framework of the lambs gives them the founda-

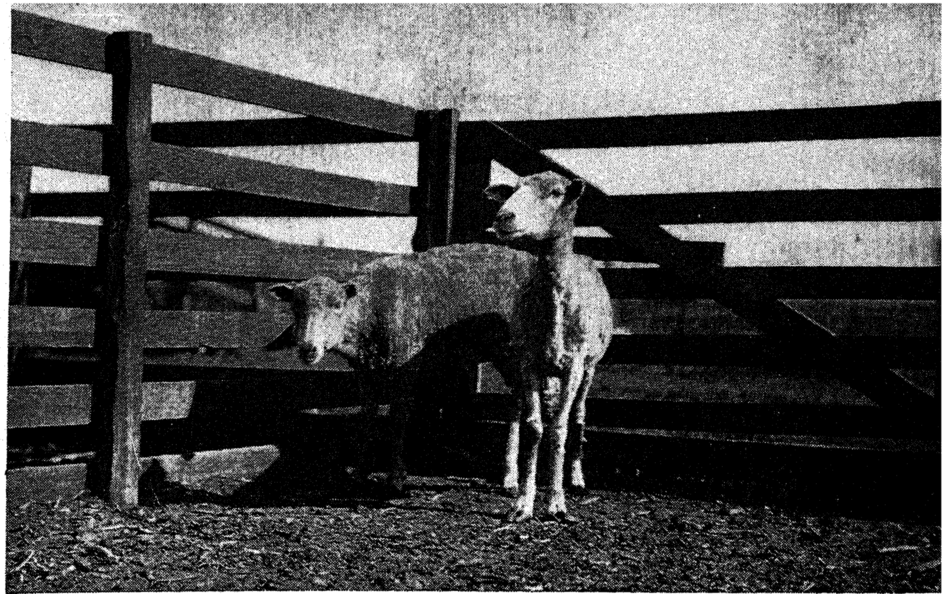
Courtesy University of Illinois

These choice white-faced western breeding ewes show ample evidence of productive capacity.

tion upon which they can add to the weight they already have. For field feeding the fleece must be dense to provide the protection needed under extreme changes in weather conditions. While these matters may be given some consideration in the case of fat lambs, they become of much greater importance in the judging or selection of feeder lambs, and they are considered from a quite different viewpoint.

Determining grade of breeding sheep. In selecting breeding sheep, the interest is primarily in what the offspring of such sheep will be like and how well they will meet needs and demands. The gauging of the offspring is necessarily based upon the features of the parent stock. This is true because the offspring will resemble the parents in certain particulars through the influence of heredity, although there will be many things about the offspring which will be due to the influence of environment. Thus, it is impossible to estimate accurately the future usefulness of breeding sheep with respect to the character of product. But this does enter into any consideration with respect to grading or appraising.

Form, quality, and condition are basic items in sheep of this class. But such matters as constitution, health and soundness, substance, fleece, placing of legs and ability to travel, femininity, age, and type or breeding are also important. Production presupposes certain strains and hardships, and, to grade high, breeding sheep must possess attributes which suggest the ability to withstand pro-



Courtesy University of Illinois

These common breeding ewes are decidedly lacking in form, condition, and evidence of strong constitution.

duction difficulties. Good health, sound teeth and udders, strongly made bodies of ample substance (bone) supported by sturdy feet and legs and carrying fleeces that not only afford protection but will be of satisfactory amount and quality are requirements for a high grade in any group of breeding ewes. Evidence of such desirable features in the wool are gained by a consideration of its length, density, covering on the main parts of the body, including the underline, fineness of the fibers and uniformity of the fibers on all areas of the body. Fleeces that are kempy, off-colored, lacking in attractiveness, or otherwise undesirable would be considered as items which would be related to the grade assigned.

Only ewes that were free of readily noticeable defects in all of the matters mentioned would be appraised as fancy selected breeding ewes. In fact, only slight defects could be overlooked if they were to be given a grade of choice. As defects became more numerous or more pronounced, the grade would be lowered. Cull ewes would be subject to severe criticism from several standpoints and could not be considered as showing much promise as producers. Coarse, staggy ewes would be lacking in femininity and hence not of top grade. Ewes which conformed to the type or showed the general breeding and characters of some well-known breed would be considered more entitled to a high grade than those which could

only be described as nondescript. Age changes the appearance of animals, and this may have the effect of reducing the grade of ewes. In any group of ewes to be graded as a lot rather than singly, uniformity would be an important item in the assignment of grade. The higher the grade, the greater the value for breeding purposes should be. This does not mean that choice breeding ewes will always be more profitable than those of lower grade, for external conditions may change and thus change values, but the quantity and quality of the product should be greater from the higher grades of ewes.

Similar considerations would be true with respect to rams, although some of the items would, of course, be changed.

Purebreds. Most purebreds are not graded, but if it is desired to designate their grades, the above considerations would be included together with such items as relate to the means of distinguishing one breed from another.

Weight. Weight is a factor of much importance in selecting sheep or lambs. It is generally not considered as a part of the matters that determine market grade, but it may have a significant influence on value. Thus it is possible to have lambs that are equally satisfactory in all respects except in weight. Lambs of medium weight may sell for more than heavy-weight lambs per pound. This is a reflection of the demand, but weight is not in itself a means of satisfying a certain demand. Lambs of the same weight but differing in grade do not sell for the same price so often as lambs of the same grade but of different weights. Thus, there is always the influence of conditions existing at any particular time. There are, however, few times when medium-weight lambs that are satisfactory in other respects are penalized in price in favor of lambs of either heavier or lighter weights. When spring lambs first appear on the markets, they may weigh no more than 70 or 75 pounds and yet command top prices. However, as numbers increase, those which are heavier are usually most desired. Consumers are prejudiced against heavy-weight lambs, partially because they are not certain they are not being sold meat from mature sheep rather than lamb if the carcass is heavy and the cuts large. There is greater demand for small cuts. Newer methods of cutting the lamb carcass will overcome some of the dislike for heavy carcasses.

Weight is also a consideration in feeder-lamb selection. Large lambs are stronger and hence more able to withstand some of the

hardships that may be incident to feeding than are little lambs. Another matter is the relation of the weight at the start of the feeding period to the weight desired at the close. Certainly, if one wished lambs to weigh about 85 or 90 pounds when they were fat, he would not select thin lambs weighing 75 pounds and requiring 30 or 35 pounds increase in weight before they were fat.

In the case of breeding sheep, size or weight is of significance. Little sheep eat less feed than large ones. The lambs of big sheep grow faster than those of little sheep. Other things being equal, big sheep yield heavier fleeces. For breeding, medium size is apt to be best for most conditions. Medium-sized ewes weigh from 135 to 175 pounds.

CHAPTER 23

★ *The Organization and Operation of a Sheep Enterprise* ★

A decision as to whether to undertake sheep raising should be based on facts pertaining to the industry. This will involve a consideration of the possibilities of profit, the relation of sheep raising to proper land use, the production requirements (especially feed and pasture), the equipment needs, the labor requirement, the relation to other farm or range enterprises, the climatic and other features of the locality, and markets and transportation facilities. In addition to these things, the attitude of the operator toward sheep and the knowledge he possesses of their characteristics and management are important items. Various types of sheep production may be chosen. Some operators will prefer lamb feeding, some may choose to maintain a grade flock and raise market lambs, and others may find greater appeal in the handling of purebreds.

Some thought should be given to the size of flock that is to be kept; the breed and types to be produced; where and how the animals are to be obtained to establish the flock; how it is to be maintained, increased, or decreased in size; the amount of capital needed, and the time required to secure a return.

Sheep raising as a part of the farm enterprise may be of major or minor importance, depending upon certain considerations. It will be a minor unit on many farms, but it should not be so small as to make its neglect of no consequence or the total returns of no importance. It will be a major enterprise on those farms where the owner has an especial liking for sheep and enjoys the tasks involved in caring for them and the farms are well suited to their production.

If sheep are to be kept, they should be a definite part of the farm business, and their place should be determined on the basis of what they may contribute to the efficient operation and to the

income and pleasure of the farm. They should be looked upon as useful farm animals and not as scavengers given the job of living only on such feeds as other animals find distasteful. While they may do much in "cleaning up" the farm, this is incidental to the main object of the flock. The products of sheep are mainly meat and wool, but they are by no means limited to these. These products are useful, and in many areas essential, to man's comfort. Few farm products exceed wool in value per pound. Sheep raising on any farm will have to compete with other activities that are or may be carried on, and the decision whether a flock shall be established or continued will depend upon the relative profitableness of the farm with and without it. In starting a sheep enterprise, the operator must consider the effect upon the system or type of farming and the relation this may have to soil management and conservation.

Sheep may be successfully raised in all parts of the United States if the producer is interested in them, studies them, meets their needs for nutrients, shelter, and protection, and maintains their health. Some advocate sheep on every farm, but this is not necessary or advisable under conditions now existing. Sheep thrive better under some conditions than under others. It is generally assumed that a certain topography is best for sheep, and, although they apparently prefer lands that are rolling, this is not an essential, as many flocks have been kept on level farms for many years. It is, of course, true that some rolling lands should be kept in pastures of grasses and legumes. Sheep are well adapted to harvest and utilize such plants. It is not likely to be sound judgment to consider land that is so poor as to be productive only of the very poorest types of plants to be well adapted to sheep. Land that is suitable for sheep must be capable of developing good pastures, and to do this it must not be extremely deficient in minerals needed for plant growth. In many cases certain fertility elements may need to be supplied for sheep raising to be successful, just as they would be needed for the success of any other enterprise. Any farm that is capable of growing good pastures and roughages may be considered suitable for sheep production. In considering its suitability one would also keep in mind its size, other livestock to be kept, crops to be grown, and amount of labor available. Sheep raising is not an enterprise to utilize large amounts of labor.

One should also consider the nature and requirements of sheep. They are ruminants and therefore are physiologically

adapted to the utilization of relatively large amounts of pastures and roughages compared with the amounts of grain. Studies on this question show that sheep utilize about 13.6 acres of pastures and forages for each acre of grain; whereas, beef cattle use 4.8 acres of the former to each acre of grain, and hogs, only 0.2 acre of pastures and forages for an acre of grain. To use this acreage to advantage, sheep must be in good health, and the pastures and forages must have certain characteristics.

The profit to be derived from a range or farm sheep enterprise will depend on many things. Among these will be the demand for and the price paid for products of sheep. Sheep production is on a domestic basis; that is, there is not now produced in this country a surplus for which a market must be found abroad. In fact, so far as wool is concerned, the United States is now and has been for many years on an import basis.

The federally inspected slaughter of sheep and lambs during the past few years is shown in the table following.

TABLE 2

Federally Inspected Slaughter of Sheep and Lambs 1935–1944[1]

Year	No. head
1935	17,644,000
1936	17,215,000
1937	17,270,000
1938	18,060,000
1939	17,241,000
1940	17,351,000
1941	18,100,000
1942	21,624,000
1943	23,363,000
1944	21,876,000
1945	21,200,000

Since the average live weight was between 85 and 90 pounds and the average carcass weight about 40 pounds, the total dressed weight averaged approximately 775,000,000 pounds, or about 7 pounds per person. These quantities are far below the corresponding amounts for beef and pork. There are, from time to time, campaigns for the public to eat more lamb, but in view of the above facts it would seem that before this is possible with respect to domestic lamb more lamb must be produced. Many people in this

[1] Bureau of Agr. Econ. U.S.D.A.

country do not eat lamb, as shown by studies[1] in Minneapolis where only 13 per cent ate lamb but 90 per cent ate beef.

Sheep production for meat is on a lamb basis. Lambs constituted from 90 to 95 per cent of the market receipts during the past few years except for the liquidation of flocks during the war years. Lambs and yearlings constituted 93 per cent of slaughter for the years 1937–1941, but this percentage declined to 79 per cent in 1943 and was 84 per cent in 1944. Hence, anyone contemplating sheep raising must realize the importance of good management and other practices that will result in producing desirable market lambs. This is further shown by a comparison of the relative prices of lambs and mature sheep during the last three months of the year 1941. The average lamb price (good and choice grades) in Chicago was $11.70 per hundredweight, and for ewes (common and medium grades), $5.51. Although the grades are not comparable, the far greater value of lambs is clearly shown. There is a wide range in lamb values too, depending upon their desirability for market use.

Wool data may be indicative of opportunities available if wool continues to compete on a favorable basis with other fibers. The following figures show in pounds the production and consumption of wool in this country during recent years. The percentage of the total amount consumed, that was made up of wool produced in this country, is also shown.

TABLE 3

UNITED STATES WOOL PRODUCTION AND CONSUMPTION ON A GREASE BASIS[2]

Year	Production	Consumption	
		Total	Per cent domestic wool
1935	427,531,000	748,400,000	94.8
1936	419,063,000	666,400,000	83.6
1937	423,654,000	579,500,000	72.7
1938	425,680,000	513,900,000	92.5
1939	428,216,000	673,900,000	88.0
1940	436,564,000	683,300,000	77.1
1941	456,368,000	1,021,500,000	52.2
1942	459,073,000	1,123,094,000	51.3
1943	449,578,000	1,109,140,000	41.9
1944	418,094,000	1,050,345,000	32.7
1945	387,017,000 [a]	1,012,781,000	24.8

[a] Preliminary estimate

[1] Wool Grower. Feb., 1938, and Jan., 1941.

[2] Livestock, Meats and Wool Market Statistics. 1944. U.S.D.A.

The peacetime per capita consumption of wool is relatively small, about 4 to 6 pounds annually. It is not perishable and therefore enters readily into world trade. Wool is an important defense material, and consumption during the war years totaled approximately one billion pounds of raw wool annually. This rate of consumption is not likely to be maintained, but it seems domestic wool, if of good quality, will continue to be an important commodity.

Profits will depend upon how intelligently and economically sheep are handled and how well the lambs and wool meet market demands. Producers must endeavor to keep pace with these matters, and to follow market prices closely. There are many changes taking place with respect to the types of sheep. As an illustration may be mentioned the competition that the Rambouillet is meeting in the western regions. Types once suitable may now be surpassed by others.

Sheep must have abundant feed, but they are limited in their ability to consume large amounts of concentrates and still yield products economically. Economy of production may be more important in some phases of the industry than in others, but it is a matter to keep in mind.

A reasonable expectation from a farm flock would be a lamb crop of 100 to 150 per cent; that is, the number of lambs from a given number of ewes would equal or exceed the number of ewes. Some flocks surpass this. Many range outfits do not produce more than 75 lambs per 100 ewes. Some are 10 or 15 per cent below this, while a few exceed 100 per cent. The wool produced per ewe, if the sheep are at all suitable in this respect, should equal 7.5 to 10.0 pounds. It requires careful selection and good management to produce fleeces that will exceed 10 pounds on the basis of 50 per cent shrink.

Like other animals, sheep are greatly handicapped in their producing abilities if unhealthy. Death losses of ewes will amount to 8 or 10 per cent yearly. Losses of lambs from birth to market will amount to 10 to 25 per cent of the number dropped. The lower these items are kept the more successful the enterprise. Sheep raising is no different from other endeavors, and a certain production is needed to cover costs. Production in excess of that is the source of profit.

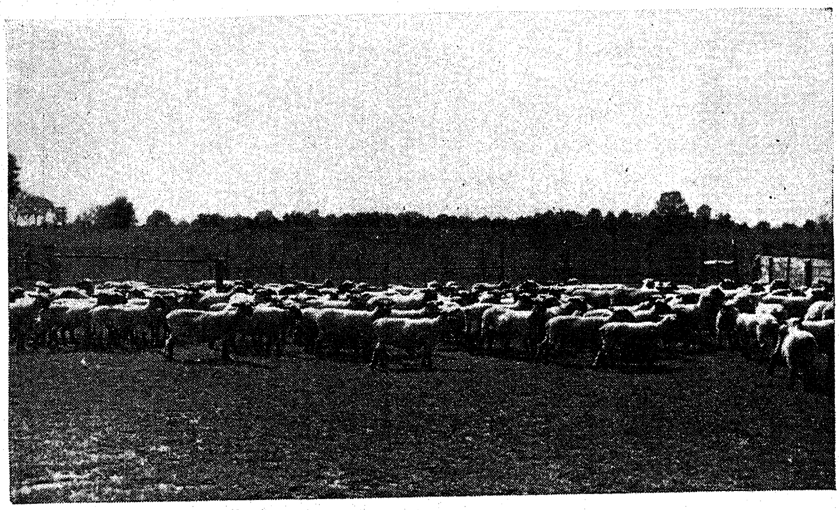
Breeding animals depreciate in value from year to year. The

amount of depreciation will, of course, vary and will depend to a large degree upon the initial value and how long they remain useful. Most sheep have passed their most productive period by 7 or 8 years of age, and they are usually most productive from 2 to 6 years of age. Depreciation is caused by age, injury, and barrenness. Depreciation probably amounts to 10 to 15 per cent of the total gross costs.

Establishing and maintaining a farm flock. It is a common recommendation that the flock should be small when started and that only a few head are necessary to gain experience. The more limited the size of the flock the more limited the experience gained from it. Further, the investment in sheep on most farms will be relatively small, and if the numbers are few the owner may lose interest in them because the return will be small in comparison with the returns from other units of the farm. It would be folly indeed to start with a very great number if no one on the farm had worked with sheep previously. The size of the farm will have a relation to the number that should be kept, but it is reasonable to recommend a flock of at least 35 or 40 breeding ewes for a farm of about 160 acres. Much larger flocks may be kept if desired, for records show no decline in returns due to increased numbers.

The considerations in recommending a flock of the above minimum size are several. The investment will be large enough so that it will not be neglected. If only a few are kept it is not likely that they will be considered important enough to be given good care. Further, suitable equipment can be provided, and the limited expense for such items of shelter and feeding equipment as necessary is justified. Farm sheep raising does not call for elaborate equipment, but the flock cannot be given the care and attention it should have if suitable equipment is lacking. Another matter favoring the keeping of at least about 40 ewes is that the owner is justified in purchasing a good sire. No one can make sheep raising pay if he does not produce reasonably good products, and "a couple of ewes" do not make the use of a good ram possible. However, a good ram may be purchased and used on a flock of about 40 ewes, and the sire charge against the lambs will be one of the smallest items of expense. Approximately 100 to 120 ewes would comprise a three-ram flock.

Labor cannot be efficiently utilized on a very few head. In most farm flocks the yearly man-labor requirement per ewe is usually



Courtesy University of Illinois

The number of sheep in this farm flock make it one of the important enterprises on the farm.

less than 5 hours. In some studies this was as low as 3 hours per head. The value of the labor amounts to from 6 to 10 per cent of the cost of keeping an ewe a year. The labor demand is very seasonal, and many duties in caring for a flock are not arduous, although there are some tasks requiring considerable strength.

A flock of the recommended size will also make use of pastures to advantage and will be a significant factor in the control of many kinds of weeds. It is common practice to consider from 5 to 7 sheep the equivalent of an average cow. Thus, such a flock would be equal to only 6 or 8 head of cattle with respect to pasture needed.

The products of 40 ewes would justify some care in marketing. Those who have only a few sheep often know nothing about the value of the products and market them in outmoded ways. He who has from 40 to 60 lambs to sell will receive a fair-sized gross return under normal conditions and can afford to try to develop the lambs well. The wool from 40 ewes will weigh 300 to 400 pounds and as a valuable farm product ought to be looked upon as worthy of being marketed in an approved manner.

If purebreds are being raised, there will often be enough good ones to show or sell for show use, the advertising costs per head are

certain to be lower, and the numbers that can be offered will justify buyers coming from some distance to make selections.

The matter of finance often limits the size of the enterprise, especially in the beginning. But this is a controllable factor to a large extent and need not continue to be of paramount consequence if the operator has favorable conditions and knows the fundamental principle of capital accumulation: thrift. Not all are equally capable of handling large enterprises.

Requirements. It is well to consider the total requirements of such a flock and to estimate what the returns may be.

According to a Minnesota report,[1] a flock of 40 ewes would require the following per head annually: grain, 128 pounds; hay, 500 pounds; pasture, 200 days; man labor, 3 hours; and horse labor, seven-tenths hour. If a ration of one-half corn and one-half oats were used, 40 ewes would eat 80 bushels of oats and 46 bushels of corn—the amounts yielded by 3 to 4 acres. Ten tons of hay would represent the yield of 3 to 5 acres and would take care of the winter roughage requirements for the flock. Productivity of pastures varies greatly, but an acreage of 5 to 20 acres should be ample in most sections. Only 120 hours or 15 eight-hour days would be needed to care for the flock from a man-labor standpoint. Along with this would be 28 hours of horse labor. Shelter and equipment are listed at 30 cents per head, and for the 40 ewes a shed or barn that provided about 15 square feet of floor space per ewe would need to be 20 x 30 feet. Shearing, veterinary services, et cetera are listed at 25 cents per head or a total of $10. This is perhaps too low, as in many places shearing will cost 25 cents or more a head.

Reports from Kentucky[2] show 338 pasture days and 0.6 acre as the land required for each sheep. Grain and hay per head are given as 38 pounds and 200 pounds respectively, man labor at 5 hours, and horse labor one hour per ewe yearly. Other items are not very different from those listed in the Minnesota study. However, conditions vary not only from state to state but within a state, and it is unlikely that these can be more than approximations. Important factors in these matters are the kind of sheep, the operator, and his system of management.

Before dismissing the matter of the size of the flock, it is inter-

---

[1] Minn. Agr. Exp. Sta. Bul. 283.
[2] Ky. Agr. Exp. Sta. Buls. 383 and 385.

esting to note the following figures regarding this matter for the country as a whole.

TABLE 4

NUMBER OF SHEEP SHORN IN THE UNITED STATES IN 1930[1]

No. shorn per owner	No. of producers	Per cent of all producers	Pounds of wool shorn	Per cent of total wool
1–24	275,438	58.0	21,984,000	7.5
25–49	100,164	21.2	23,735,000	8.0
50–99	50,849	10.7	24,429,000	8.2
100–999	39,562	8.4	73,760,000	24.9
1,000–4,999	6,160	1.3	96,538,000	32.6
5,000	744	0.2	55,516,000	18.8

The organization of a range-sheep business is much different from that of a farm-flock business. One of the chief differences is in the number of sheep handled as a unit. On farms the number kept is based on several considerations such as already mentioned. On ranges the number handled as a unit is based chiefly on the number that one man can handle. On many ranges one owner may have several men looking after bands of sheep. Each band will number from 1,000 to 1,500 ewes and their lambs. The number in one flock varies with the type of range, kind of sheep, number for which a permit has been obtained, and other factors. However, the number in one group is essentially based on a man unit. More can be handled per man on the range than on a farm, where from 300 to 500 head would be considered all that a man could handle. Both on the range and on the farm extra help would be needed at lambing and at shearing times.

Obtaining the ewes. Obtaining the ewes is often a puzzling task, for there are such matters as the time of year and the locality in which to buy them, the general type and breeding, and the price that should be paid.

In many regions it is, of course, possible to buy ewes in the locality. If they are thrifty and reasonable in price and the flock has been a productive one, this may be the best source. Usually, the numbers are limited, and if many are wanted it may be necessary to place an order with some of the better known commission firms or dealers on the markets. If one is interested in ewes from the western ranges, they may at times be purchased direct from owners or

[1] Bur. Agr. Econ. U.S.D.A.

through dealers. One should be careful, however, to find out about the reliability of the parties with whom he is dealing.

Breeding ewes are often sold during the summer months before the breeding flocks are "made up" for the fall, and then is often a good time to buy. Some ewes are sold after they are bred, but the price is always higher than at other times. Occasionally, ewes are offered as "pairs" with lambs "at side," but transporting them is rather difficult.

Sheep are roughly classified as native and western or range sheep. There are certain differences usually found in them, but these are as much or more due to the breeding or general type as to the locality in which they have been raised. Many western ewes are predominantly of fine-wool breeding or represent various crosses, usually involving fine-wool types and those designated as long-wools. At present, most natives are mainly of the medium-wool mutton or meat type. There are, however, many sheep of medium-wool ancestry, especially on the sire's side, coming from the ranges of the West and being used for breeding purposes in the Corn Belt and other sections. Many ewes are bought from the ranges, as farmers find it more profitable to buy rather than raise replacements. In other cases range ewes are preferred because there have been many cases of internal parasites in native ewes from poorly managed flocks. Better methods of parasite control have changed this somewhat.

Compared with range ewes, natives are usually considered as being more prolific, generally larger, show more mutton type, are mostly "black-faced," and often have greater infestations of internal parasites. The latter is not always true, and the same may be said of the other points as well. But, there are many instances where these differences do exist.

Range ewes are often lower in price than natives, but this should not lead to the purchase of something that is not of the type and breeding desired. For most farm flocks it is likely that ewes having the characteristics of the medium-wool breeds will perform most acceptably. Very many desirable market lambs are raised from fine-wool ewes bred to medium-wool mutton-type rams. Likewise, the wool shorn from such ewes may be sold at satisfactory prices, although it is not likely that very short, fine wool will sell without some discount compared with longer, medium-grade wool. This will be explained later, in Chapter 35.

The price of ewes usually is based to a considerable extent on age, size, general condition, type, and the uniform attractiveness of the lot. The price asked has some relationship to the value of lambs and of wool. It is a common expectation that the cost of a ewe and her keep will be equaled by the sale of her lamb and wool the first year.

Grades or purebreds? This question is often asked. The answer rests with the individual concerned. Certainly there is no surplus of good purebreds, and the number of all purebreds compared with the number of all sheep is small indeed. In 1930 there was one purebred out of every 107 sheep in this country. Purebreds that possess the distinctive features of their breed and have marked utility characteristics too are an important adjunct of the commercial sheep industry. It is from such flocks that rams to sire market lambs are obtained.

It is less costly to purchase grades, and it costs less to produce them: they often do not need to be given such good care, and they do not need to be of extraordinary quality to sell at the top price for their kind. Neither do they need to be individually identified. Purebreds must be identified and recorded in the registry association for the breed. To market grades does not require the finding of special outlets, advertising, and the entertainment of visitors who may or may not prove to be buyers. Because of the smaller investment in animals and equipment, there seems to be less likelihood of failing financially with grades.

Although the producer of grade lambs should use good rams, it is not necessary that they have all of the features often emphasized by those who raise purebreds. The man who raises grades may produce some excellent individuals, but they cannot be sold to such good advantage and at so high a price as outstanding purebreds.

Often it is said that the producer of grades cannot make so significant a contribution to livestock breeding, and at times he may not be in a popular class. However, his products do serve mankind well if these products are of good quality and carefully handled and marketed. For most farms the production of grades is and will be most suitable.

The breeder of purebreds must strive always to have only superior individuals, have them correctly identified, know other breeders and their work, know the true value of animals to price them right, keep his products before the public, and maintain cer-

tain public contacts. He should study production more carefully and realize purebreds must have some capabilities and features that make them superior to grades, or they are of no greater value.

Characteristics desired in ewes. The value of a ewe is measured by the pounds of good-quality market lambs and wool she will produce in a given time (year) and the economy with which this production is accomplished. The quantity and quality of the products of sheep are just as important as the amount and kind of products obtained from dairy cattle or other animals or as the crops obtained from a field. There are certain quality standards that should be met, but after that the amounts of the products yielded per ewe become of great moment. On the other hand, it is unwise to think only of quantity without considering this in relation to the costs involved. Some of these matters are more or less controversial, but it is important to know what features have an influence upon the productivity of ewes and what features about them are likely to be most often associated with satisfactory performance.

Health. Often this is listed as soundness, constitution, or as thriftiness. It is evident that animals not in good health are handicapped in their abilities to produce. It is, of course, not unusual for well animals to become sick or injured, and one would not willingly start with or keep ewes that would be sure to be severely hampered when undergoing the strains of heavy production. There are many indications of health, and there are many evidences of unthriftiness. Health is shown by a general alertness and appearance of strength associated with ease and quickness of movement. Sheep in good health carry their heads well up and there is a fresh, bright appearance to their eyes. Their fleeces and skins have a brightness that is never found in sick animals.

A lack of health is shown by a dull appearance, listless movements, paleness of the skin and membranes of the eyelids; often, there is considerable coughing, discharge from the nose, scouring, and lack of flesh. Ewes that are receiving good feeds or are on good pastures should carry a reasonable amount of flesh, depending upon the season of the year and the stage of development of their lambs. Sheep that cannot thrive on good pasture should not be purchased or kept.

Some sheep may be in good health but be very lacking in what is usually spoken of as constitution. Animals that have very small features, extremely fine bone, and narrow, shallow bodies are sel-

dom able to consume feeds in sufficient quantities to support good lamb and wool production. Ewes that are generally said to be hardy and have an abundance of stamina and constitutional vigor have strong-appearing heads and bodies. The muzzle is broad, the chest is broad and deep, the body has a "roomy" appearance and seems very muscular and is supported on legs that have sufficient bone to give them a sturdy rather than a weak appearance. Constitution is more or less associated with certain features of form, but some well-made sheep have weak constitutions. Constitutional vigor is undoubtedly a reflection of well-developed nervous and glandular systems and is not entirely a matter of width and depth of chest, matters that are influenced greatly by the amount of fat.

Soundness. Soundness is a term frequently used when referring to the usefulness of an animal. In sheep the term is ordinarily used in describing the teeth or udder. Sheep are said to be sound in mouth and udder if all of the teeth are present and if the udder is free of lumps or evidence of injury. As sheep advance in age, they are likely to lose some of their teeth and are then referred to as broken mouthed, and if all the teeth (incisors) have been lost they may be called "gummers." Such sheep should of course be avoided as should those that have "parrot mouths" or those with the lower jaw so long that the teeth do not press against the cartilage pad of the upper jaw. These latter defects are likely to be transmitted to the lambs and are, therefore, undesirable in breeding sheep.

Age. The age of sheep is usually estimated by the teeth. There are, however, some general indications of age that are important indications of the effect age has had. Some of the features listed in the discussion of constitution and soundness are of course, in many instances, related to age, but the value of a sheep and the possibility of future usefulness are rather closely associated with age. Ewes are in the most productive period of their lives when from two to about seven years of age. There are many exceptions, but the vast majority of them produce their first lambs at two years old and continue without much evidence of decline until they are seven, when they have had six crops of lambs and will have yielded seven fleeces of wool. Although many continue to yield good amounts of wool and may raise lambs satisfactorily beyond that age, most show significant declines. This will be shown most markedly during the time they are nursing their lambs, as this is one of the times of heaviest strain.

Some studies show the fleeces of two-year-old ewes are 10 to 20 per cent heavier than the first fleeces and also heavier than those shorn when the ewes are older.[1] However the first fleece weights are reliable indicators of the weights of later fleeces. Fleece weights do not decline greatly until the sheep reach seven years of age. After that, the wool is apt to be lighter in weight and less well grown. Since this is the rule, it is a good practice to have the greater portion of the ewes range in age from two to probably six or seven years.

There is some inquiry about the purchase of ewe lambs for breeding. Much difference of opinion exists regarding the advisability of breeding ewe lambs so that they will yean their first lambs when they are approximately one year old. Practically all men who raise purebred sheep oppose the practice. Range sheepmen, also, do not follow the practice; perhaps this is not because all are opposed to it but because the conditions under which they operate make it very inadvisable: they cannot give the young ewes extra care, and most of them are not equipped to give special attention to the lambs. However, some farm-sheep raisers have followed the practice for years and think it profitable. A study of the matter has been made by the North Dakota Agricultural Experiment Station.[2] Of 122 ewe lambs bred in the test, 104 dropped lambs and 81 of them raised lambs. The conclusions from the test follow. The pregnant ewe lambs gained faster in weight to lambing time than the group not bred. The ewes that raised lambs as yearlings were about the same weight as 122 similar ewes bred to lamb at two years old when both lots were 31 months old. The latter group attained the weight of maturity at 21 months of age compared with a comparable attainment at 31 months for the group bred as lambs. Both lots maintained their weights equally well thereafter. Early breeding had no effect on the wool yield. The lambs from ewes lambing their first year were lighter in weight at birth than later crops from either group. At the end of six years the early-bred group had produced in six lamb crops an average of 496.4 pounds of lamb, and the other group in five lamb crops, 465.4 pounds; hence, there were 31 pounds more for the group bred as lambs. One effect of early breeding seemed to be that the teeth tended to be lost sooner, as only 45.9 per cent of that lot had sound mouths at an age of seven years compared with 56.8 per cent having sound mouths in the lot

[1] Texas Agr. Exp. Sta. Bul. 311.
[2] N. Dak Agr. Exp. Sta. Bul. 285.

lambing first at two years of age. Both lots were fed the same. Perhaps added minerals might have been of value to the ewe-lamb lot.

Data from another study made in South Dakota[1] are in general agreement with the above. One hundred nineteen ewes were bred as lambs when about 9 to 10 months of age. Of that number 84 produced lambs. The ewes that raised lambs when only a year old were lighter in weight than three other groups when an age of 18 to 19 months had been reached. However, there was no difference in weight when an age of about 2½ years was reached. Thus, the weight disadvantage due to early breeding is a temporary matter, but it does result in delayed maturity with respect to size. The 84 ewes lambing at one year of age dropped 89 lambs of which 60 were weaned. During five years the early bred group produced a total of 50 more lambs with a weight of 2,572 pounds in excess of a similar group bred first as yearlings. There were no significant differences in the average grease weight of the fleeces from either group. It is stated in the report that breeding ewe lambs might be useful as an index of selection, since those that conceive might be more fully developed as measured by body size, and early sexual maturity might be an indication of a high level of fertility. This latter point has not been proved.

On the basis of another test[2] involving purebred ewe lambs, the size of the lambs seems to be an important consideration in deciding whether or not to breed them. Ewe lambs of the large breed (Hampshires) showed no difference later in life compared with others bred as yearlings, but those of a small breed (Southdowns) continued to show a difference.

Another matter about which there is some inquiry from time to time concerns the advisability of buying old ewes that have passed their period of usefulness in the western sections for use in the Corn Belt or other regions where feed is abundant and conditions less severe than on the ranges. Many of these ewes are "broken-mouthed" and are said to be good for one crop of lambs. They would be bought in the summer or fall, bred, raise their lambs, and sent to market along with or shortly after the lambs. Since the cost of such ewes is low, it seems to many that the undertaking should be very profitable. The chief handicap to profit, however, arises be-

[1] SPENCER, D. A. ET AL. Performance of ewes bred first as lambs compared with ewes bred first as yearlings. Jour. An. Sci. Vol. 1. No. 1. 1942.
[2] N. Dak. Agr. Exp. Sta. Bul. 316.

cause the ewes are often rather expensive to feed and must have relatively more concentrates than younger, more vigorous sheep in order to raise their lambs, and they sell for low prices when returned to market. There are farmers who have followed such methods for years and who have secured returns they consider satisfactory. Others have tried it and are convinced that ewes which are a little more costly and sound in teeth are more profitable: they yield heavier fleeces, they raise lambs that are capable of more rapid growth because of a greater milk supply from their mothers, and the lambs are more cheaply raised as they depend more on pasture.

The Nebraska Station,[1] working with old ewes, found that they had a high feed requirement. In six months the average ewe ate 5.6 bushels of ground ear corn, 10 pounds of cottonseed meal, 287 pounds of alfalfa hay, and 209 pounds of corn silage. They showed a gain of 20 pounds in weight. Their lambs ate an average of 1.4 bushels of ground shelled corn, 11 pounds of linseed oil meal and bran, and 74 pounds of alfalfa hay. With the prices that existed at the time of the study, there was no profit made.

Farm-sheep raisers are especially interested in having ewes produce twin lambs. Some studies have been made to learn if there is any relation between age and multiple births. Records of 9,868 Shropshire ewes [2] indicate that the percentage of multiple births increases from 1 to 4 years, then remains fairly constant until 7 or 8 years. The age of the ram has no effect so long as the numbers of spermatozoa are large. The number of lambs produced by a ewe is determined by the ewe.

There are no thoroughly convincing data that show ewes of any particular age to be outstandingly more productive than those of other ages. (See Table 5.) Matters relating to lamb-raising ability are of course quite as important as those which relate to the ability to produce twins. It is quite necessary that the ewe have both capacities. If one eliminated young ewes that were barren and those that did not produce twins, it might be reflected in greater productivity of twins in older ewes; however, the production of twins at one lambing does not indicate twinning will occur at later lambings.

Size. Size of ewes is a feature that has received some study in experiment stations and has been discussed by producers from many angles. Certainly no answer will suffice for all situations, but

[1] Nebr. Agr. Exp. Sta. Bul. 250.
[2] Jour. Agr. Res. Vol. 22. No. 4.

TABLE 5

AGE OF EWES AND LAMBING RECORD [1]

Age of ewe years	No. bred	Barren and aborting		Total lambs	Per cent multiple births	Average number lambs	
		Number	Per cent			Per ewe lambing	Per ewe bred
1	31	—	—	56	74	1.81	1.58
2	539	53	10	849	66	1.75	1.67
3	419	28	7	699	67	1.79	1.66
4	320	11	3	606	78	1.96	1.83
5	189	5	3	346	70	1.88	1.75
6	77	1	—	135	67	1.78	1.72
7	32	1	—	55	65	1.77	1.72
8	11	—	—	19	—	—	—
9	3	—	—	6	—	—	—
10	1	—	—	2	—	—	—
11	1	—	—	2	—	—	—
Total	1,623	99	6	2,775	69	1.82	1.71

it is known that if one wishes lambs that will grow fast and attain marketable weight of 85 to 90 pounds in a relatively short period, the larger ewes are more suitable for this purpose than those of less scale. But under conditions where quick maturity is not necessary, lambs from small ewes will attain satisfactory market weights, and the small ewes can be maintained on a less amount of feed than the large ones. This is simply in line with the rather widely known fact that rate of growth is related to size at maturity and that the size at maturity, conditions of feed and environment being the same, is related to the size of the parents.

It is as certain that there is no profitable advantage in extreme size as it is that there is no profitable economy in extreme smallness. Under farm conditions ewes weighing from about a minimum of 125 pounds to a maximum of approximately 175 when in good condition will usually be satisfactory. However, size is not measured by weight alone, and it is important that ewes have sufficient scale and substance to give them needed capacity to eat adequate amounts of feeds and to give them needed "roominess" of middles for lamb development. Likewise, there is a relationship between size and wool production. This relationship is not to be taken as meaning that any big ewe will shear more wool than any little one, but, of a group of ewes similar in other respects, the larger ones are very apt to produce more wool than the smaller ones.

[1] Jour. of Genetics. Vol. 33. No. 1.

Courtesy Otto Berlage, Galena, Illinois

Ewes of good size and weight are most suitable for farm or range flocks.

The important relationship of body weight in the selection of yearling range ewes and their later production of lambs and wool was shown in a study[1] of 758 Rambouillet, Columbia, and Corriedale ewes. Regardless of breed, the larger ewes excelled in the amount of products obtained.

Studies [2] relating to size in ewes of fine-wool breeding show progressive increases in weights of average lamb crops with increases in the weights of ewes, and there was also a tendency for the

TABLE 6

SIZE OF EWES AND LAMB AND WOOL PRODUCTION

Weight of ewes	No. of ewes	Av. wt. of lamb crop	Pairs of twins	Av. wt. per pair	Av. wt. of fleece
lbs.		*lbs.*		*lbs.*	*lbs.*
100 or less	28	71	7	113	8.4
101–110	68	80	46	124	8.5
111–120	82	84	57	124	8.9
121–130	64	90	65	132	8.9
131–160	35	92	30	131	9.4
av. 116		84		127	8.8

[1] TERRILL, C. E. and STOEHR, J. A. The importance of body weight in the selection of range ewes. Jour. An. Sci. Vol. 1. No. 3. 1942.

[2] Mont. Agr. Exp. Sta. Bul. 242.

larger ewes to raise larger percentages of twins and twins that were heavier. In the Montana study three to five lamb crops and six clips of wool from 277 ewes yielded the data shown in Table 6.

It is evident that a part of the differences in the weights of the lamb crops was due to the greater percentage of twins raised by the larger ewes, but the same relation is shown by the weights of the single lambs. Using the same weight divisions as in Table 6 for the ewes, the number of single lambs and their average weights were:

TABLE 7

SIZE OF EWES AND WEIGHTS OF SINGLE LAMBS

Weight of ewes	No. of lambs	Average weight
lbs.		*lbs.*
100 or less	113	68
101–110	259	72
111–120	302	76
121–130	217	78
131–160	113	81

It was noted that the size of an ewe is a more accurate measure of her ability to raise heavy lamb crops than is the lamb-producing ability of her dam, and that culling the small ewes from the band would have eliminated no exceptional lamb producers and few that were equal to the average in lamb production. Size of the ewe is not sufficient as the sole criterion in selection but was listed as the most accurate single measure observed to indicate ability of fine-wool ewes to raise heavy lambs under the conditions in the state of Montana. It is likely the same is often true in the Central States.

Some further data [1] may be cited in relation to size and lamb

TABLE 8

BREED OF EWES, SIZE, AND LAMB PRODUCTION

Breed	No. of ewes	Average weight	No. of lambs	Average weight
		lbs.		*lbs.*
Rambouillet	2,256	124.5	1,671	71.2
Corriedale	1,508	116.1	1,184	69.3
Columbia	1,517	134.0	1,094	76.6

[1] U.S.D.A. Cir. 308.

production, although the data pertain to different breeds rather than to size differences within a breed. (See Table 8.) These data, however, are only indicative and far from definite in reference to size.

Although animals are commonly considered on a per head basis, it has been suggested that production should be calculated on the basis of per hundred pounds live weight. At the Maryland Station [1] the weight of lamb at 70 days of age, per hundred pounds of breeding ewe maintained, decreased as the weight of the ewe increased. On this basis the production of small ewes is greater, usually, than that of large ewes; and the proponents of small ewes state that a larger number may be kept on the same amount of feed as fewer large ewes, and thus the same total production obtained.

At the Illinois Station [2] a small breed and a large one were compared. Hampshire ewes weighing 153 pounds when bred ate 50 per cent more feed to maintain their weight during eight weeks of pregnancy than Southdown ewes weighing 109 pounds. The lambs from the Hampshires weighed 20 pounds more per head at 117 days of age than the lambs from the Southdowns weighed when 164 days old. A Hampshire ewe and lamb required 30 per cent more total digestible nutrients than the Southdown ewe and lamb. The Hampshire lambs weighed 30 per cent more.

The matter will remain controversial for some time, but it is undoubtedly sound practice for producers to place reasonable emphasis on size. Lambs are not sold on a basis of the relation of their weight to the weight of their dams.

Form. Form or shape is another consideration in choosing ewes. In general, animals tend to resemble their parents, and since the returns from lambs that are sold is determined to some extent by their form, it is wise to select ewes that show evenness of outline and good development in all parts. The author is, however, convinced that the most important consideration should always be given to general matters of form and little attention paid to minor details. Depth, width, fair length, a strong back, and depth of flank and rear quarters are far more important than extreme smoothness over the shoulders or rump. There seems to be a relationship between the major items of form and a strongly constituted, easy-keeping animal. Form is best judged by the eye rather than by

[1] Md. Agr. Exp. Sta. Bul. 380.
[2] Jour. Agr. Res. 60: 473–486. 1940.

handling, and the ewes are best judged when they are carrying relatively short fleeces. The use of a good ram on rather plainly made ewes often results in a great improvement of the form of the lambs compared with the form of their dams, but such lambs are not likely to be so well made as those from ewes having good forms mated to an equally good ram.

Wool. Wool is not only a source of income but is also a protective covering of the animal. Hence, ewes selected for farm or range flocks should have dense fleeces that will grow to a length of about three inches or more in a year. Dense wool affords greater protection, and wool that is as long as indicated has for many years sold at a higher price than wool of much less length. Further, good shearing ewes have the body well covered, especially the underline. It is a mistake to seek so great a covering about the head that the animals are unable to see when the wool has grown a few months. There is apparently no reason why a heavy-wool producing ewe cannot also be a good lamb producer. As stated earlier, ewes are generally at their best as wool producers when from 2 to 3 years old, and there is a marked decline likely after 7 years old. There is a high enough correlation between the weight of one fleece and the weights of later fleeces from the same ewe to make culling on this basis advisable.[1] One would be unwise to choose ewes whose fleeces are black or any color other than white.

Temperament. Temperament, or disposition, should not be overlooked. Some matters of importance in this regard cannot be observed except at lambing time, but those ewes refusing to nurse their lambs certainly show a very undesirable disposition. A good disposition is not contrary to an active, alert animal. Some breeds are more easily handled than others, a matter of temperament.

Condition. Condition, or the amount of fat the ewes are carrying, may be related to their health, and in the case of ewes that are old enough to have had one or more crops of lambs, it may show they are non-breeders or very poor lamb raisers. The purchaser wants ewes that are "easy keepers," but it is a mistake to discard ewes that are thin but vigorous and take fat ewes instead. It is many times true that the best-appearing ewes in the band have not raised lambs or have not done so satisfactorily. Very fat ewes—those that are fat at all times—often have small weak lambs. Ewes that are "patchy" or "gobby" about the rump are undesirable, as they are

[1] Wyo. Agr. Exp. Sta. Bul. 127.

not easily settled at breeding time. Emaciated ewes may be heavily parasitized or otherwise afflicted and should be avoided unless the purchaser is prepared to assume a more than average risk.

Regardless of the attention that may be given to the selection of the ewes for the flock when it is established or additions made to it, there are many factors that relate to the productiveness of ewes that cannot be discovered by looking at them. Attention should be given to these when ewe lambs are selected for replacements.

Uniformity. Uniformity in the ewe flock is an aid in developing a uniform lamb crop, and there is nothing that adds more to the appearance of a group than to have them all of an even quality. The most attractive flocks are even in breeding and size and are similar in other respects. The products of an even lot of ewes are apt to be more attractive to buyers because the products too are likely to be uniform and hence sell to advantage. Preference in the community is often an important item in selecting a general type and breeding, as combined shipments from several flocks will be less likely to vary in quality. However, the buyer of ewes must keep his needs and desires in mind and make his selections in accord with them.

In selection of large numbers of grade ewes, it is usually the practice to remove from the group those that are not wanted rather than to put into it those that are wanted. Thus, in buying a hundred ewes from a lot of several hundred, the buyer may arrange to have the privilege of rejecting or sorting off 10 or 15 per cent. From the main band about 115 or 120 would be "cut off," and then the buyer would "throw out" the less desirable ones until he had 100 head left. If such selection is not arranged, the 100 head would represent a "gate cut"; that is, the first 100 counted through the gate would be the group bought.

Purebreds. Purebreds are selected on the above points, but, in addition, some attention must be given to the peculiar features that are the distinguishing characteristics of the chosen breed. Although such items as face color, size and color of ear, and so on must not be overlooked in selecting purebreds, most emphasis should be on the utility features because these have most bearing on production from the market viewpoint, and purebreds should possess as much or more utility as the best grades and show the distinctive breed characteristics besides.

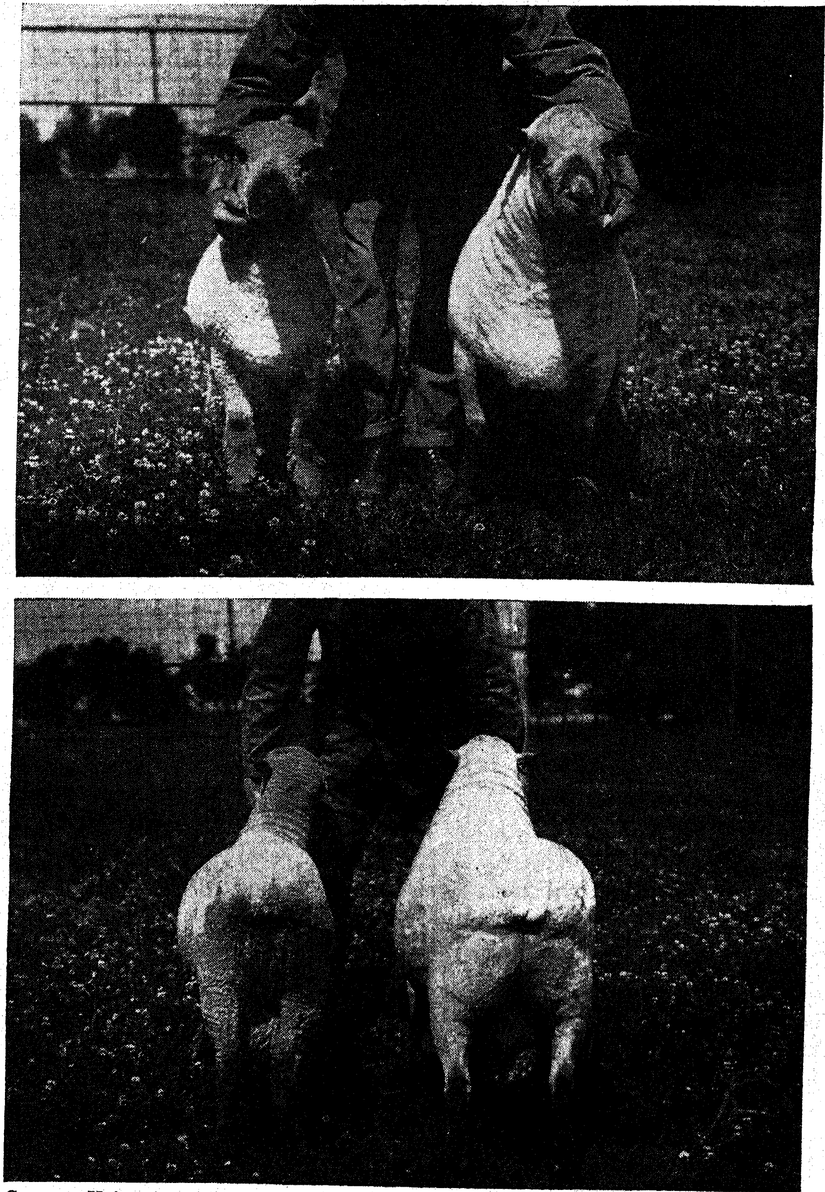
Characteristics to consider in selecting rams. The ram is the

most important individual in the flock so far as the inherited features of the lambs are concerned. Hence, one should try to buy a ram or rams that are superior to the majority of the ewes in the flock. One should also remember that although the ram is the most costly animal of the flock, the sire charge as a cost of producing lambs is less than the ewe charge or the cost of feed. It is not a wise policy to economize in the purchase of a ram, since his influence is shown by all the lambs. It is, of course, only prudent to buy a good ram as cheaply as one can, but it is short-sighted, indeed, not to buy a good ram because the price is considerably above the average value of the ewes.[1] A ram to be used on forty ewes is not too high priced, if he is a good sire and a good individual, if he costs from eight to ten times as much as the average ewe in the flock. But price does not determine breeding ability. Neither does ownership.

If possible the ram bought should be a purebred, but the present purebred population is insufficient to make this possible in all flocks. Further, a ram should have more to recommend him as a sire of commercial lambs than the mere fact that he is from ancestors registered in one of the record associations. However, of two rams that have equally desirable individuality, the one a purebred and the other a grade, the purebred is likely to be the more satisfactory sire. Any ram should be from a flock that is known for its productive abilities.

A strong, vigorous constitution, a sturdy, muscular body, supported on moderately short legs with good bone and feet, are essentials to seek in any ram. Good rams have deep, wide chests, broad loins, thick, full quarters, a deep twist, and a pronounced thickness of firm flesh. All these are points of excellence in market lambs and, therefore, should be present in sires of lambs. Lambs need to be vigorous and strong, and vigor and strength are not found in lambs if these characteristics are absent in their parents. Some emphasis should be given to the development of the masculinity of the ram. This is shown by a strong head, rather heavy neck, and well-developed sex organs. Since much of the value of a ram depends upon his activity, evidence of this should not be over-

[1] A problem will make this very clear. How much does a $50 ram cost per lamb if bred to 40 ewes per year for two years if a lamb crop of 140 per cent is raised each year? If a 90 per cent crop is raised each year? Use the figures above but buy a ram for $25 and calculate how much more one could afford to pay for a ram if he increased the sale price of the lambs fifty cents per head, the owner to keep twenty-five cents per lamb in each case as profit.



Courtesy University of Illinois

Good rams have wide, deep chests, and full hindquarters. These two rams show how great the difference within a breed may be.

looked. Activity and a mean disposition are not necessarily associated. Neither are activity and ability to sire lambs, but a lazy ram is a poor investment. Rams with mouth defects, weak legs, pasterns, or feet, or those that have one testicle carried in the abdomen should be avoided.

The fleece. The fleece of the ram should not be overlooked, particularly if the ewe lambs are to be added to the flock. In such cases, the fleece should be of the quality desired in the ewes, and there should be ample evidence that it is abundant in quantity. As in ewes this is shown by its compactness or density of growth, its length, and how well the major portion of the body is covered. The fleece should have an appearance of uniformity on all parts of the body and be free of black fibers and other undesirable features described in the chapters regarding wool.

Size. Size is often emphasized by the men who raise market lambs. There is some criticism of this by those who think quality is of more importance than size. However, it is seldom, if ever, a mistake to choose a ram that is average or above average size rather than one much below average size for the breed that he represents. It is often that the fleece is not all removed at shearing time in order to give the impression of extra size. The ram should have good size because he has a skeleton and a large amount of muscling; he should not be heavy just because he is very fat.

As in the case of ewes, some preference is shown by certain sheep raisers for rams that were born as twins. Although the ram, twin or single, cannot possibly fertilize more ova than are released from the ovaries at the heat period of the ewes, it seems logical to consider that he may influence the fecundity of his descendants, and, on that basis, twin-born males may be more desirable than those born as singles. Certain it is that such selection is not working against prolificacy, although there is apparently little evidence to show that it is so helpful in increasing twin production as is sometimes thought.

Breed. Breed is always an important matter when selecting rams for a flock. A number of studies have dealt with the question of what breeds of rams are most suitable to use on certain types of ewes, and some have dealt with the fertility of rams at various seasons. The latter work, carried on at the Missouri Experiment Station,[1] was limited to the Hampshire and Shropshire breeds, but

[1] Mo. Agr. Exp. Sta. Res. Bul. 265.

it suggests that this may be an important matter if one desired early lambs, for it was found that Shropshires were lowest in fertility in July, August, and September, usually recovered late in October, and then maintained a high level of breeding activity during the winter. The same tendency was observed in the Hampshires, but the decline was never so marked; and recovery of a high degree of fertility occurred in September. These observations were made under conditions existing in that state, and the same situation may not exist elsewhere. However, it is likely that such breed differences do exist elsewhere. In the University of Illinois flocks, the purebred Hampshires tend to breed earlier in the fall, and hence lamb earlier than Southdowns, which are usually somewhat earlier than Shropshires. There are many individual exceptions within breeds, however, and some rams and ewes in all breeds are more or less exceptional in reproductive traits, as in other respects. Certain aspects of feeding and management have a bearing on the breeding abilities of rams at various seasons.

The California Experiment Station [1] reported results obtained in a study extending over a period of six years in which rams of the Hampshire, Suffolk, Shropshire, Southdown, Romney, and Rambouillet breeds were used on ewes of Rambouillet breeding. The results may be measured on various points, but the point that is sure to interest the men engaged in the production of lambs for the market is the monetary value of the product of the lambs sired by the rams of the different breeds. Their value is the result of the price per unit (pound) multiplied by the number of units. The price per pound is set by many factors, but the main features of the lambs that influence it are their form and quality and the degree of finish (fat) they carry at marketing time, for these relate to the dressing percentage and the value of the carcass. This latter is, of course, a matter of feed to a great extent, but it is also related to the features inherent in the lambs themselves. Furthermore, results, so far as pounds live weight are concerned, are in experimental work usually and, perhaps very rightly, based on the weight of the lambs at a rather uniform age; whereas, the lighter lambs at that age would in a relatively short period attain the same weight as the heavier ones have already attained. However important consideration of the length of time required to attain a given weight may be, lambs that have the ability to reach market weight in the Corn Belt

[1] Calif. Agr. Exp. Sta. Bul. 598.

before the hot days of summer, or on the range when grazing is good, have worth-while advantages over slower-growing lambs.

The California study involved 120 Rambouillet ewes in six lots bred to six different breeds of rams during a six-year period. Each lot of ewes was bred to a ram of a different breed each year. In addition to the Rambouillet ewes, another group of 80 Romney-Rambouillet crossbred ewes were bred to rams of four breeds. The data in Table 9 is based on lambs that averaged about 120 days of age in the case of the Rambouillet ewes and 95 days for those from the crossbred ewes.

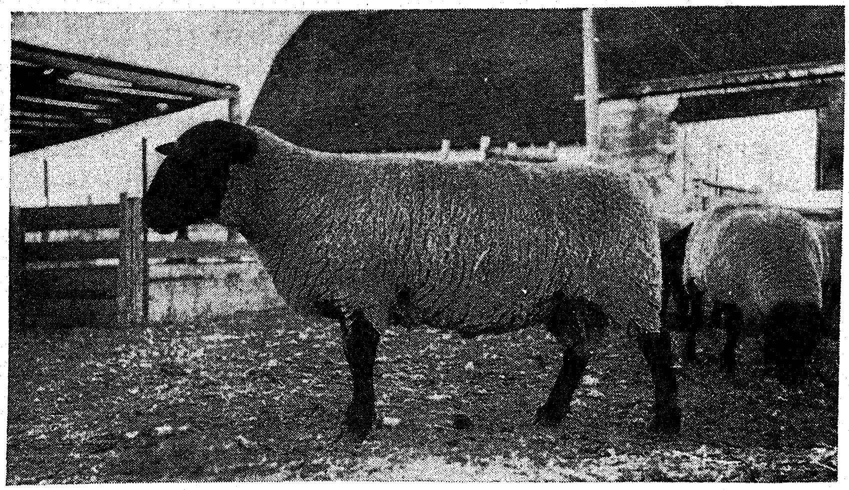
TABLE 9

THE INFLUENCE OF THE SIRE ON THE WEIGHT AND QUALITY OF LAMBS

Breed of ram	Number of lambs raised		Av. final weights[a]			Percentage[a] of lambs graded				Dressing percentage
	Single	Twin	Single	Twin	All	Choice	Good	Medium	Common	
	Lambs from Rambouillet Ewes									
Hampshire	42	102	86	73	77	23	40	28	9	49.9
Suffolk	27	111	87	76	78	22	35	35	8	50.0
Shropshire	50	85	80	68	73	24	41	29	7	51.0
Southdown	49	92	79	66	70	34	38	23	5	51.6
Romney[b]	27	62	76	67	70	25	29	35	11	48.9
Rambouillet	42	104	78	69	71	6	20	49	25	48.4
	Lambs from Crossbred Ewes									
Hampshire	96	41	76	64	69	26	30	32	11	51.3
Suffolk	100	40	75	65	69	28	33	27	12	51.1
Shropshire	103	37	66	61	63	15	34	38	14	51.2
Southdown	102	37	64	57	60	29	34	25	11	52.1

[a] All decimals in weights and grades omitted.
[b] Four years.

These data show that the size of the sire is reflected in the growth rate of the lambs, as the rams of the larger breeds produced the heaviest lambs. It is also shown that the sire has an effect upon the quality of the lambs. When the price of the lighter lambs is increased, their disadvantage due to less weight may be offset. Likewise, the advantage due to weight of lambs by the larger breeds of rams may be offset by the reduction in price per pound due to less quality. To date, most open markets in this country have not shown any great favoring of the extra quality.



Courtesy M. Barclay, Blackfoot, Idaho

Whatever breed of ram is selected, size, bone, health, and vigor are important.

Another similar investigation was made at the Wyoming Station,[1] but here some study of the effect of the sire upon the wool production of ewes sired by various breeds of rams was also made. Rams of other breeds besides some of those used in the California studies were also included. The test covered five years. The wool data refer to an average of three shearings.

TABLE 10

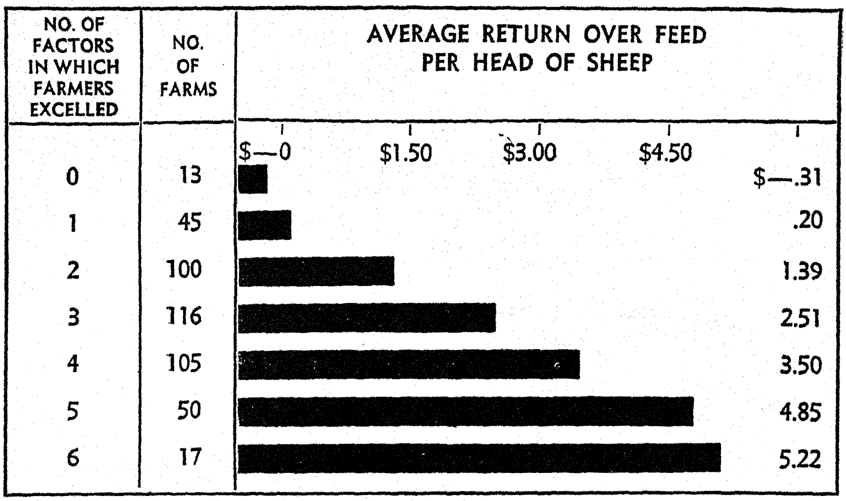
WEIGHTS, GRADES, AND SHEARING RECORD OF CROSSBRED LAMBS

BREED OF RAM	AVERAGE WEIGHT OF ALL LAMBS	PERCENTAGE OF LIVE LAMBS GRADED				AVERAGE FLEECE WEIGHT
		Choice	Good	Medium	Common & Cull	
Hampshire	74	9	58	27	6	10.8
Suffolk[a]	90	6	61	32	—	—
Southdown	70	5	67	22	5	11.1
Lincoln	76	—	28	49	23	14.8
Rambouillet	75	—	27	49	3	13.4
Corriedale	68	—	27	58	15	13.9

[a] Two years only.

It is shown that the weight of wool produced by ewes is greatest for the ewes sired by heavy-fleeced rams. The investigators reported

[1] Wyo. Agr. Exp. Sta. Bul. 210.



This chart shows the average return over feed cost per head of sheep on farms grouped according to number of selected factors in which the farmer was above average, 1928–1937.

the fleeces ranked in the following order with respect to four characteristics. In length, the rank was Lincoln, Corriedale, Hampshire, Southdown, and Rambouillet; in density and crimp, the rank was Rambouillet, Corriedale, Southdown, Hampshire, and Lincoln. In the case of fineness, the Corriedale and Southdown were reversed.

An efficiently organized and operated enterprise is dependent upon many factors. Success is not assured by emphasis on one particular thing. Selection of good rams and ewes is an important matter. Good feeding practices are important too. There are relationships between these factors, and while the independent effect of any one may be difficult to measure because of its relationship to others, the cumulative effect of several factors on returns can be demonstrated. Some important factors brought out in a study in Minnesota[1] were: (1) gross returns per head, (2) per cent lamb crop, (3) value per lamb marketed, (4) price of wool, (5) per cent death loss, and (6) feed costs. The graphic summary shown above is taken from the publication. The combined effect of the factors was strongly reflected in the returns, for the returns of farmers ex-

[1] Minn. Agr. Exp. Sta. Bul. 382.

celling in six factors exceeded those of farmers excelling only in one factor by more than 2,600 per cent.

No enterprise can be efficiently managed unless it is based on records. Flock and account records show the things that affect the profitableness of the undertaking. Without records, facts are soon forgotten or are incorrectly recalled, and then only a general idea of the enterprise is available rather than specific usable information. Records give a definite basis for checking performance and for planning improvements. Farm record keeping assistance is available in most states through the Extension Service.

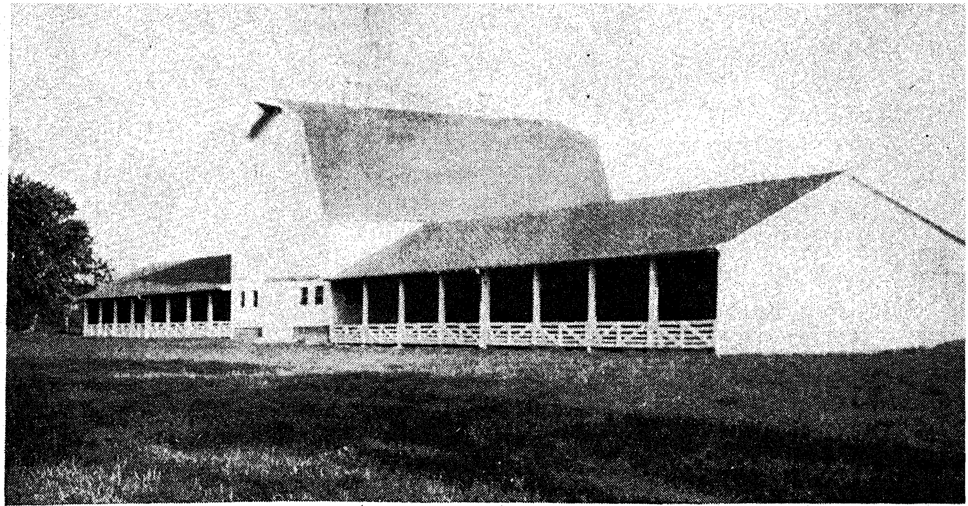
CHAPTER 24

★ *Equipment* ★

A great variety of equipment—fences, shelters, feed racks, watering facilities, and so on—is used by producers and feeders. In general, equipment is satisfactory if it facilitates handling the sheep and their feed and enables them to do well. Although the equipment need not of necessity be expensive, care should be used in planning it so that it will promote good health among the sheep and save labor in giving them good care. Good equipment has many advantages compared with that which is poor or inadequate. But it is often true that one grower or feeder having only fair equipment will succeed, while another with much better facilities fails to achieve such good results. These instances serve to emphasize the importance of "mental equipment" rather than to indicate any advantage of poor equipment. Good equipment cannot wholly make up for lack of knowledge and wisdom and a failure to understand the meaning and importance of the adage, "the eye of the master fattens the cattle."

Anyone maintaining a flock or feeding lambs should try to have suitable equipment because of the matter of safety and savings in labor and feed. Much feed is wasted because of poor equipment. The kind of shelter advisable for winter will depend upon the climate, and that suitable for one area may be unsatisfactory in another section. Where shelter is necessary, any structure that affords protection from the cold winds and severe storms and that is well drained will be satisfactory. Warmth is not an essential, even on cold days, unless the shelter is used for newborn lambs or for feeder lambs that are shorn. Sheds open on the south provide ample protection for all other classes of sheep and, at the same time, solve the question of ventilation.

The material in this text is not intended as a complete treatise on equipment. It is intended to convey suggestions regarding some of the structures which are in use in various parts of the country.



Courtesy L. T. Dwyer, Franklin, Indiana

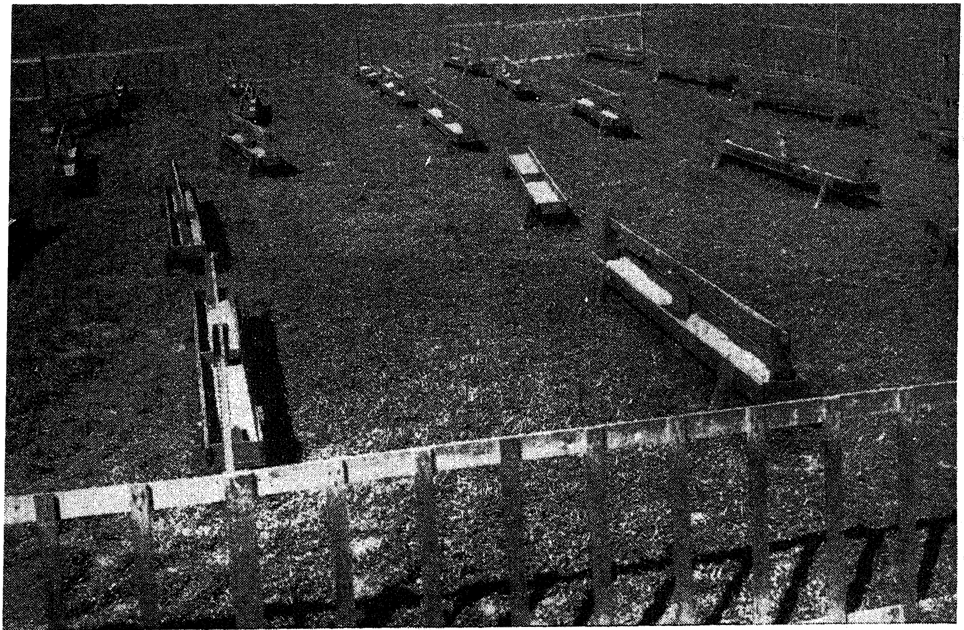
A well-planned barn and adjoining sheds are adaptable to any kind of sheep production in many parts of the country.

Buildings. Barns generally have storage space for feeds, and, because of this, some producers and feeders prefer them to sheds. However, barns may not be as suitable as sheds since ventilation is often not so thorough, and they are frequently poorly lighted because of the lack of sufficient windows. Sheds are also less costly, as they are more simply constructed and require less material to build. Feeder lambs and other sheep thrive better in sheds than in closed barns.

Earth floors are more suitable than any other kind for sheep. It is advisable to have the floor in the barn or shed raised or filled about three or four inches above the level of the surrounding lots and to have the lots graded so the water will drain away.

Space needed. Breeding ewes require from 12 to 16 square feet of floor space per head and feeding lambs, from 6 to 8 square feet, exclusive of the space used for feed racks and other equipment. To provide space for a farm flock of 40 ewes would require a shed about 20 by 30 feet. For a double-deck load of feeder lambs, about 300 head, a shed 30 by 60 feet would be the smallest that could be used, unless the feed racks were placed outside. Where all of the feeding equipment is in the shelter, a shed 40 by 60 would be better.

Lots. The lots or yards adjoining the barn or sheds need not be large. If the lots are about the size of the shelter, or somewhat larger, they will be of sufficient size. Lambs being fattened do not



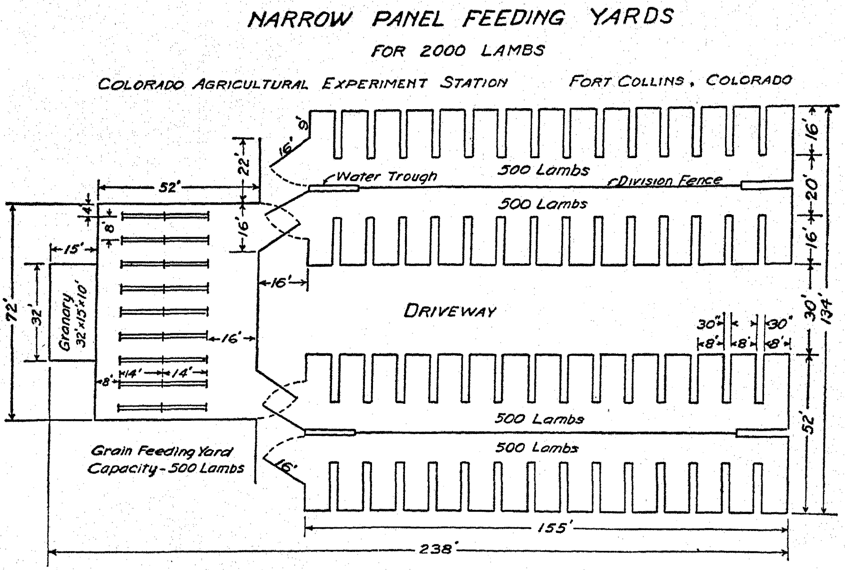
Courtesy University of California

This well-planned creep affords easy entrance and plenty of room about well-designed troughs. Creeps are also built in barns or sheds in farm-sheep-raising areas.

need a large area for exercise. In fact, experimental data indicate that lambs gain faster and more economically if they are not allowed too much exercise. Very muddy lots are detrimental to the well-being of sheep or lambs, and sheds and lots should be located on well-drained areas as a means of promoting health. Such a location also aids in conserving the value of the manures.

Fences. The best sheep fences are of woven wire. Fences that are 36 inches high will serve to confine most sheep, but it is best to have a higher fence around the entire feeding area or pasture as a protection against dogs or other predators. Much fencing is poorly constructed from the standpoint of long-time use, and, in many instances, the arrangement of gates is very poor. These may seem like items of small moment, but there is nothing which contributes more to the ease with which large numbers of sheep can be handled than the arrangements of fields, paddocks, and the gates through which the animals and the caretakers must pass.

Dogproof fences are sometimes advocated. These are hard to construct. They must be very high, at least six feet, and the wire should have diamond mesh rather than horizontal wires. The wire should be on the inside of the posts, and a single strand of wire



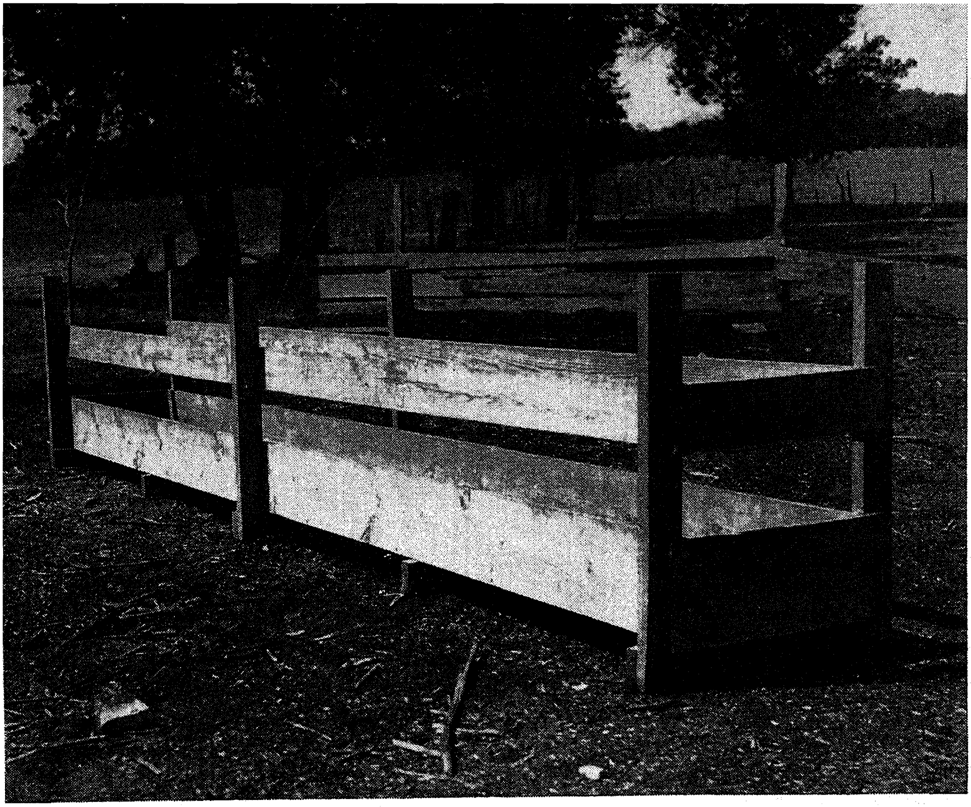
Courtesy Colorado A. and M. College

Plants such as this one are used in areas where lambs are fed without shelter. Hay is fed in the narrow panels, and the lambs go into the grain feed yard for concentrates.

should be placed on the surface of the ground on the outside of the posts. In trying to build a fence so animals will not dig under it, the wire on the outside is more effective than if beneath the ground a few inches on the inside of the posts.

Open-yard equipment. Where the climate and soil are such as to permit of open-yard feeding, there is no more convenient arrangement than the use of panels for feeding hay and a separate pen for the feeding of grain. The panels serve for fence as well as roughage feeders for the lambs at all times when they are not eating grain. The panels are arranged in a zigzag fashion to reduce the distance feed must be moved and to accommodate more lambs in a lot. The panels are usually 16 feet long and 2½ or 3 feet high. About a foot from the bottom, there is an 8-inch opening through which the lambs eat hay that is placed on the outside of the panels. The hay is usually moved up to the panels twice daily.

The grain-feeding pen is located so it is accessible to the lambs from various lots. In this pen are grain troughs. Grain is placed in the troughs, and a lot of lambs is turned in and allowed enough



Courtesy Kansas Agricultural Experiment Station

This straight-sided, flat-bottom rack may be used for both grain and hay.

time to eat. This is usually about 15 minutes twice daily, although some feeders vary the time, depending upon whether the lambs are being started on grain or are on full feed.

The grain storage should be close by. The grain troughs should provide ample space, and they should be so arranged that the lambs can move among them easily and without crowding. Otherwise, some lambs will be deprived of their share.

This type of equipment, or some modification of it and its arrangement, is probably used more than any other in the main lamb-feeding sections of the West. But it is not often seen where shed or barn feeding of rather small numbers is followed. Two men can feed several thousand lambs with this type of equipment and arrangement of facilities. From 500 to 1,000 lambs "work" best in one lot for roughage feeding and also comprise a good unit for the feeding of grain.

Feed racks. As already mentioned sheep and lambs may be

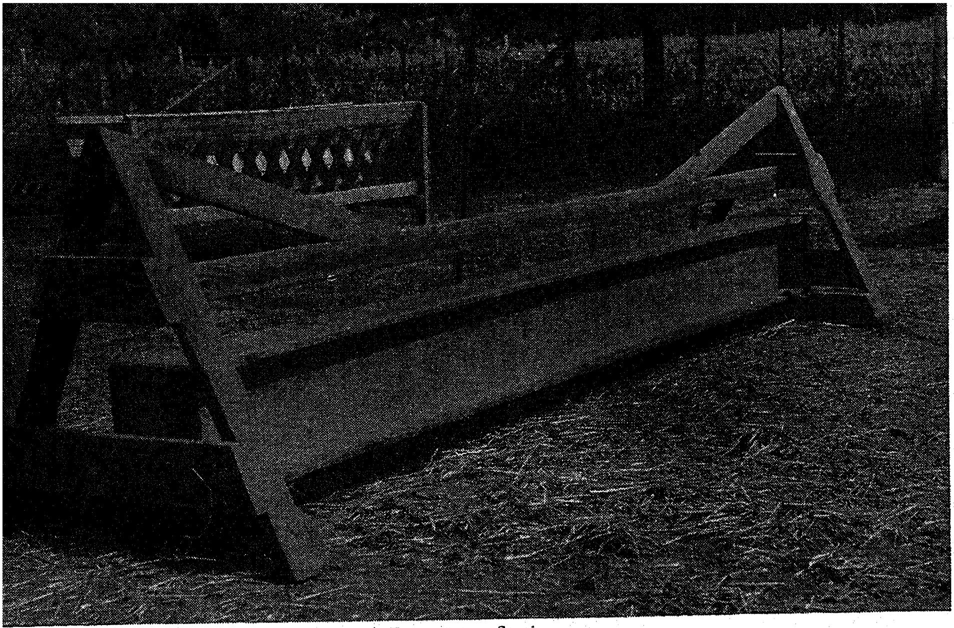
fed hay by means of an opening in the fence. There are, however, several different types of racks or bunks in which hay is fed. Although these may differ considerably in detail, they may be described in general as: 1) straight-sided, flat-bottomed bunks; 2) sloping, solid, or slat-sided racks; and, 3) grain troughs. The first two are generally used for both hay and grain. In addition to such types of feeders, self-feeders are used.

The straight-sided, flat-bottomed bunk is one of the easiest types to build and to keep clean. Although there may be some waste of long hay from such racks, they are rather well suited to all kinds of feeds and especially satisfactory in hand-feeding. These racks may be made any desired length, and the sides may have one more or less continuous opening or may be divided into small openings about eight inches wide by means of narrow, upright slats. Sheep may eat from both sides. Twenty-two inches inside measurement is a suitable width for these racks.

This type of rack is sometimes modified by making it of greater width and building a ridge or divide lengthwise through the center. The sides are then sloped from the outside of the top toward the center. Grain is placed in the troughs along the side, and an opening of about four inches between the sloping sides and the divide allows the sheep to eat hay placed in the upper part of the rack. Such racks would have solid sides. Sometimes, racks of this general type are made with slatted sides through which the hay may be eaten.

These racks are often built along alleys or walls, in which case they afford only half as much feeding space. When built in this way, a width of about 12 inches is satisfactory. When feeding, care should be taken not to get chaff on the sheep. It is well to have an arrangement so the sheep can be kept away while hay is being placed in the racks. In some instances the sides of the racks are made so that they can be turned and the rack itself closed so that the sheep cannot eat until the sides are turned to let them get the feed. In such cases a wider rack is usually built, and the racks are set so that the caretaker can enter them while he is doing the feeding. There is no objection to this if cleanliness is observed.

Grain troughs. If made separate from hay bunks, grain troughs are usually 10 or 12 inches wide and of any length desired. They should be 3 to 4 inches deep, and the bottom should be about 8 or 10 inches from the ground. Except for greater difficulty in



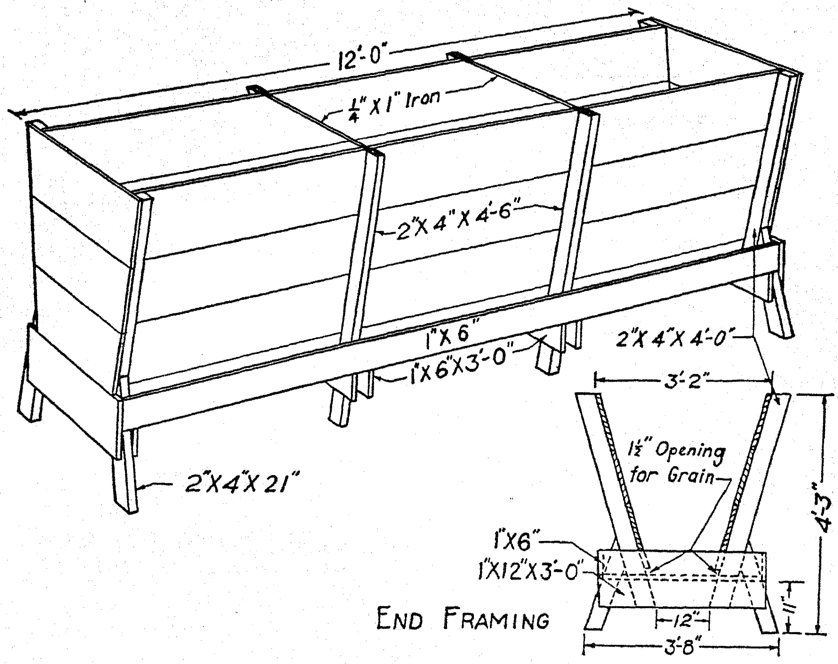
Courtesy Kansas Agricultural Experiment Station

A reversible type of grain trough is shown here. Another type of rack is shown in the background.

keeping them clean and the fact that they may not last as long, there is no reason why grain troughs should not be set on the ground. When they are on supports, it is advisable to have a guard rail along the top to strengthen the trough and to keep lambs from getting into it. The troughs should be made so that they may be easily cleaned. One of the easiest ways to accomplish this is to use eight-inch boards for the sides and nail the board making the bottom at the center of the side boards. This will make a trough that is strong and that can be cleaned by merely reversing it on the supports.

Self-feeders. Self-feeders are used mainly by lamb feeders, although some are used for breeding flocks, especially when cut or chaffed roughage is fed. Self-feeding fattening lambs generally require the use of a rather bulky ration, and the feeders must be relatively large to avoid frequent refilling. Any kind of a feeder requires attention two or three times a day to keep the feed working down properly. A feeder 12 feet long from which lambs can eat from both sides will provide sufficient space for about 50 or 75 lambs.

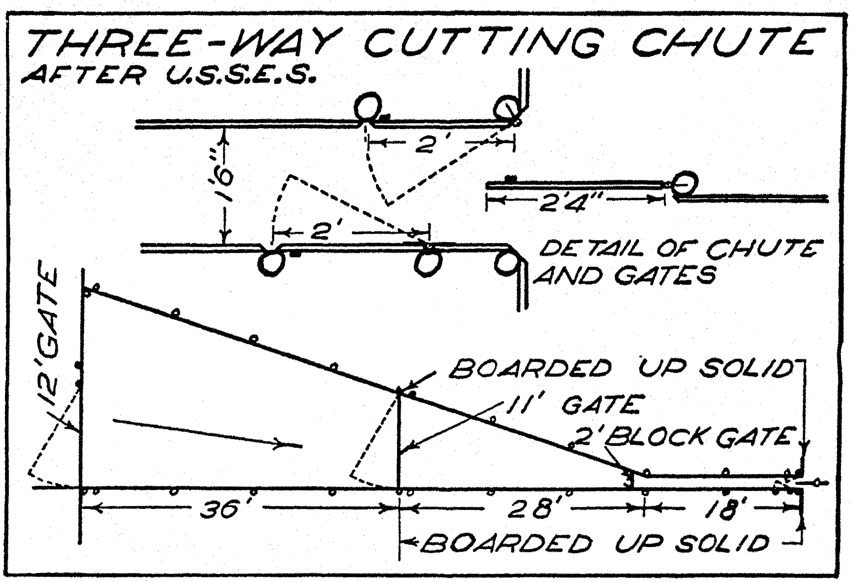
Water troughs. Sheep will drink from a half gallon to a gallon or more of water daily per head, but the amount varies greatly,



From Minnesota Extension Bulletin 215

This diagram represents a self-feeder for ground hay and grain. The opening for feed is adjustable, but attention must be given several times a day. Each linear foot of feeder space is enough for three lambs.

depending upon the weather, the temperature of the water, and the kind of ration fed. Succulent feeds reduce the amount drunk compared with the amount when on dry feed. Many sheep raisers are not fully aware of the importance of water for the flock; on the other hand, some lamb feeders think that they should endeavor to get lambs to drink exceptionally large amounts as an aid to fattening. While the use of rations to cause thirst is not recommended, careful management requires attention to watering facilities. Tanks, troughs, barrels, or other devices that are of proper size or number for the number of sheep, that are protected or have heating devices to prevent freezing, and that can be cleaned when necessary will be satisfactory. The watering devices should be located so they may be "patronized" conveniently by the sheep. Where there is much trouble from urinary calculi it is not uncommon to find



From Montana Circular No. 12

In this plan for a cutting chute, one man standing at the right end of the chute can cut the flock into four lots. A narrower chute is sometimes advisable.

poor watering facilities. A trough 12 feet long and located so lambs can drink from both sides, and equipped with a float so that it will always be full of water, will be large enough for several hundred lambs. On western ranges streams and ponds are often the main sources of water. In most cases sanitation would be promoted if farm ponds were fenced and the water piped to tanks. Snow may be the only source of water during some parts of the winter.

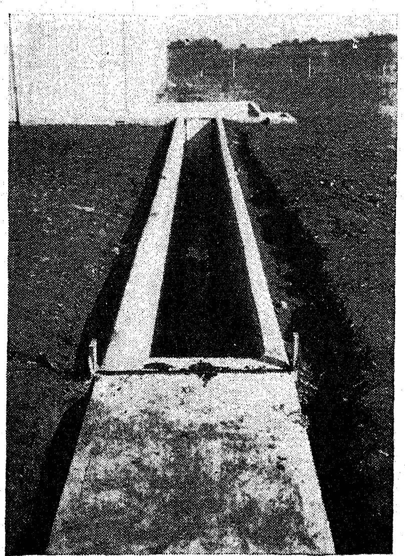
Salt. Salt may be fed as block salt, loose salt, or mixed with the feed when the sheep are not on pasture. If mixed with the feed, an allowance of one-third to one-half ounce daily will be ample. For feeding either loose or block salt, no special equipment is needed, but the boxes or containers should be large enough to allow all members of the flock to gain access frequently. When feeding salt or a mixture such as phenothizaine and salt on pastures, the containers should be made to protect these materials from rain.

Cutting chute. A cutting chute is an extremely handy and useful device for sorting sheep. It is easily made and inexpensive. By means of one gate the flock may be sorted into two lots. If

further division is necessary, one or both of the lots may be "re-worked." By means of a slightly more complicated device, the flock may be sorted into four lots by passing through the chute only one time. The chute should be 14 or 15 inches wide. If it is much wider, the sheep will be able to turn around in it, or they will try to go through in a double line rather than singly. The chute may be any length desired but should not be less than 12 or 16 feet long. The walls should be boarded up solid and be about 30 inches high. It should be on the level, if possible, or the sheep should travel up rather than down hill if it must be on a slope. They move best, too, if they do not have to go toward the sun. The fences leading to the chute should also be boarded solid. The "dodge gates" should be from 20 to 24 inches wide.

A device of this kind is one of the handiest pieces of equipment, as sheep and lambs may be sorted more readily with it than in any other way. It not only saves much work but saves much disturbance and running.

Dipping vat. A dipping vat is another piece of equipment that should be provided where sheep in any considerable number are kept. Metal tanks may be purchased and installed, or wooden or concrete vats may be built. When lumber is used, the vat will last much longer if the material is treated with creosote or other preservative. For large vats there is need of a drain in the bottom, but small ones can be emptied by dipping the unused dip from the vat with a pail. A vat that is 16 feet long is large enough for several hundred sheep. To dip that number, the vat may need refilling during the dipping operation, but, in all other respects, the vat is as efficient as a larger one. Standard dimensions, aside from length, are 4 feet deep, 10 to 12 inches inside width at the bottom, and 20 to 24 inches inside width at the top. The top of the vat should be 8 to 12 inches above the level of the surrounding ground. The inclined "ladder" which the sheep use as an exit should be 6 or 7 feet long for a vat that is 4 feet deep. A drain platform should be built at the exit end of the vat so that the excess dip carried out by the sheep will run back into the tank. At the other end there should be an incline so that the sheep can be more easily put into the vat. If the sheep enter this incline on a curve, they will not require so much pushing to get them into the dip. It also helps if the incline entrance to the vat is covered with boards or sheet metal so the sheep will slide down it and can find nothing on which to place



Courtesy University of Illinois

This concrete dipping vat is about 30 feet long, big enough for a flock of one thousand to several thousand head. The dip runs back into the vat from the drain platform. Fences are needed at the entrance and around the drain platform.

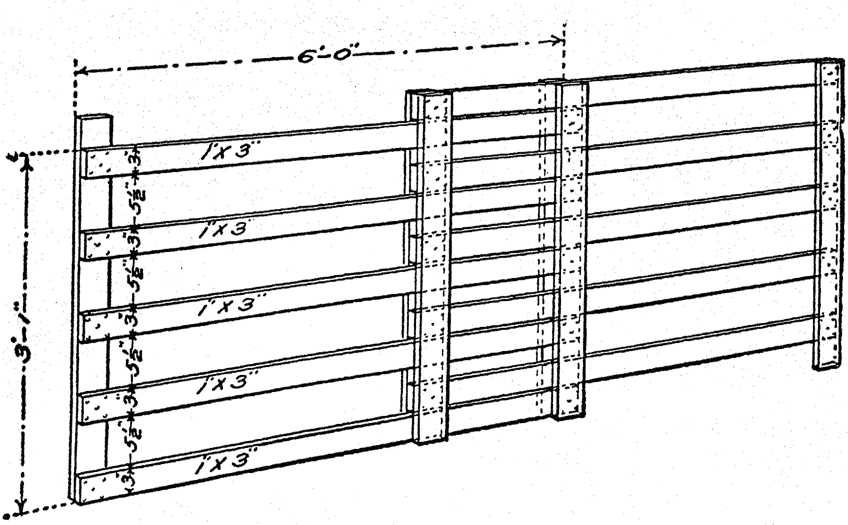
their feet in order to back out. This incline, and a short distance on both sides of the vat, should be boarded up, or the sheep will jump to the side of the vat rather than enter it.

Portable vats are now in use in some communities.

Spray vats are used by a few producers of sheep. These require the use of pressure to make a fine spray to thoroughly saturate the animals. They are generally more expensive to build than dipping vats because of the machine and piping needed. Spraying may be more widely used if some of the newer insecticides prove to give satisfactory results. Some of these may possibly be used as powders, but, in many cases, dusting sheep has not been effective in ridding them of external parasites.

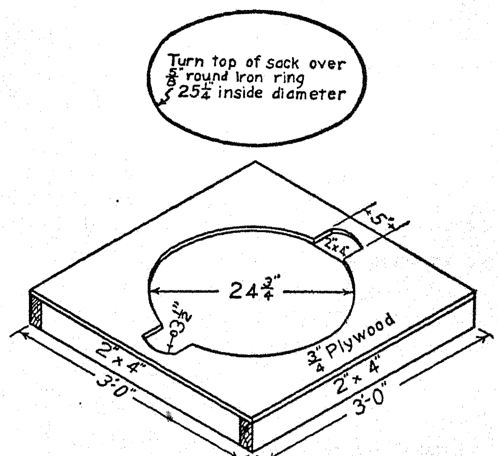
Other equipment. There are many articles of equipment, other than those mentioned, that will be needed, but most of these items will be purchased rather than constructed on the farm or ranch. There would be an exception with respect to a special shearing shed, but plans for such a structure should be made in accordance with the space requirements of the equipment that is to be installed. Such specifications may be secured from the manufacturer of the shearing machinery. A wool sack holder is handy if there are many fleeces to handle. A ring, that is 25¼ inches in diameter and made of ¾-inch iron, and a support are all that are needed. The top of the sack is rolled over the ring and hung on the support. The weight of the sack turned on the ring will keep the sack from coming off.

Such things as shears, combs, cards, trimming stands, and blankets are used chiefly by those who show sheep. Shears will be

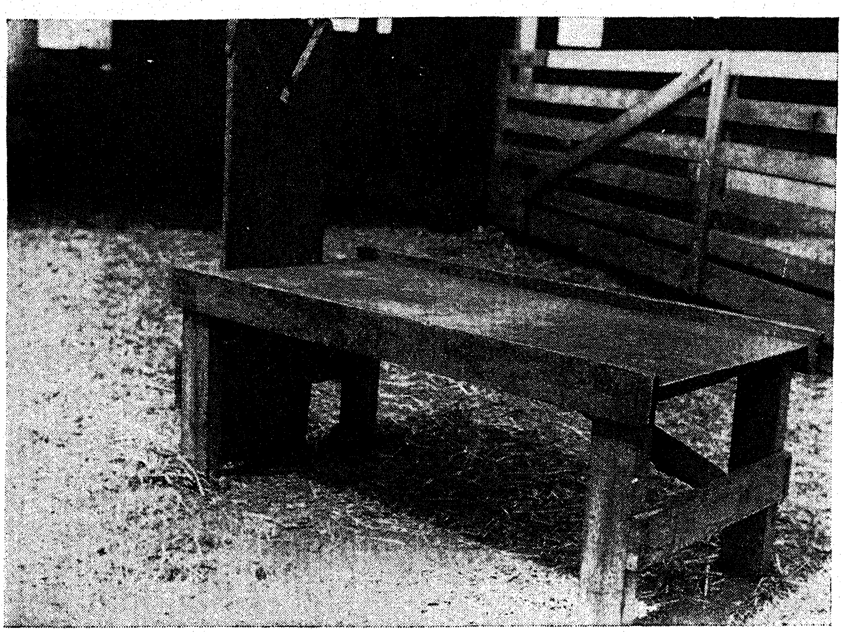


From Minnesota Agricultural Extension Bulletin 215

Top, this diagram shows an extension-type hurdle that has many uses in closing alleys or making pens. When each section is made four feet long and hinged at the center, rows of lambing pens may be set up along a wall or partition. Right, this is a diagram of a simple type of holder for wool sacks. (See the illustration on page 442.)



From Minnesota Agricultural Extension Bulletin 215



Courtesy University of Illinois

This is a simple trimming stand for holding sheep or lambs while trimming for show. The sheep's neck is placed in the large triangular notch and held by the strap. The height of the board is adjustable. The stand is folded for transporting.

needed by others for such purposes as trimming about the eyes of woolly-faced sheep or for the removal of tags. Shepherd's crooks are handy devices to catch a few sheep when the flock is on pasture or in a rather large lot. This is also useful, when specially bent, for placing on the back of a sheep's head to immerse the head during dipping. Ear notchers or punches will be needed for notching ears or for inserting tags for identification. Besides these, numerous small articles are found in the supplies kept by most flock owners. Some are mentioned at various points in the text.

CHAPTER 25

Sheep Breeding

Sheep breeding, like the breeding of other animals, is essentially an effort to reproduce numbers and control inheritance. Thus, all who raise sheep are, in a sense, breeders of them. Those who raise sheep for sale on the commercial markets are primarily interested in breeding as it concerns reproduction, although they are also interested in having the animals which they do raise of good quality and possessed of other desirable characteristics. Their efforts are concerned with utility features and the ability to make efficient use of feeds. So long as their sheep are able to subsist in the environment and return a fair profit because they have done well under those conditions and have met with a ready sale on the market, these sheep raisers are not especially concerned with further improvement. These men direct most of their efforts through the selection of rams.

There is another group of producers engaged in sheep raising who are interested in those matters too, but they also have much concern for the development of animals possessed of many other features. Many of these men are interested in producing rams for sale to the commercial sheepmen and wish at the same time to effect improvement in their own flocks and offer breeding stock for sale that will bring about some improvement in the flocks of the purchasers. These men maintain purebred flocks of established breeds, or, in some cases, are attempting to develop new and better breeds. Most of the present-day breeds were founded by men with that purpose. After such work had progressed and others became interested in the type of animal that resulted, an association of breeders was formed for the promotion of the breed and for the registration of those animals which met certain requirements. The breeders voluntarily restricted their choice of animals to descendants of those which met the initial registration requirements, and such animals were designated as purebreds. When sheep were

registered on the records of the association, their descendants were also eligible to be registered unless they possessed one or more characteristics which the association agreed should bar them from such registration.

Both groups of producers base their operations and efforts on reproduction. Because of this fact, reproduction should be thoroughly understood by all engaged in sheep raising. In addition to such an understanding of reproduction, those who are interested in the improvement of sheep should have a thorough understanding of the mechanisms by which such improvement may be brought about. This involves a knowledge of the facts relating to the transmission of the characteristics of parents to offspring and of the different methods of selection and mating. Neither of these subjects —reproduction nor genetics—can be treated in great detail, but enough will be presented to provide a basis for further study or for effective flock management.

Reproduction. Reproduction, a normal physiological process, is one of the most remarkable and important phenomena to be found in the sheep industry. Regular and repeated reproduction is the basis of the income from sheep. This is true not only of sheep but of other livestock; indeed, it is true of the whole realm of agriculture. But reproduction is not only the source of continuing income; it is upon this function that the whole science of genetics is based. Only as new animals are produced is it possible to influence the fundamental characteristics of some of the members of the species. Influential as the reproductive function is, it is in turn influenced by other matters, particularly age, health, and nutrition. Some other features of environment may also be important in relation to reproduction.

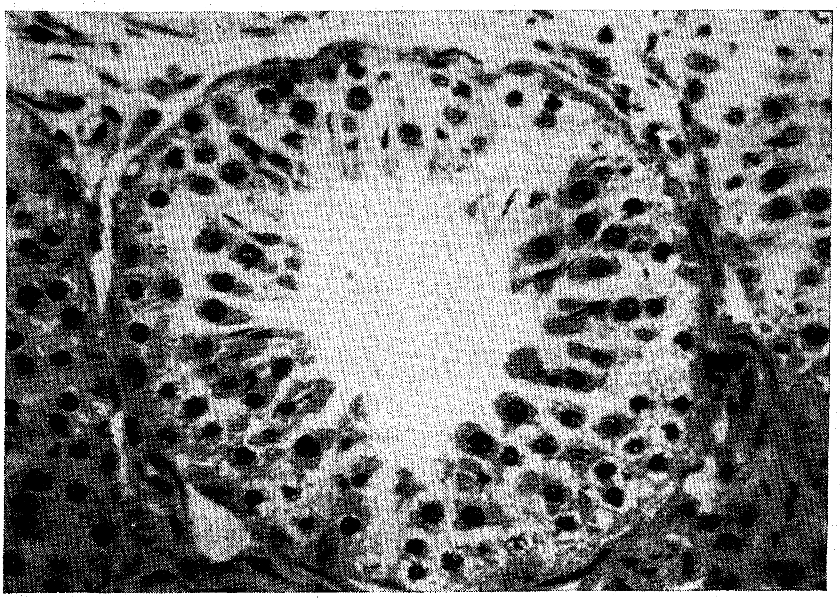
Despite the brief statement regarding reproductive physiology included in this text, this is one of the matters that should be thoroughly understood. There are many erroneous notions regarding the processes of reproduction. The student and the breeder should have a sufficiently intimate knowledge of the anatomy and functions of the male and female reproductive systems to enable them to understand what is involved in the reproductive processes and to perform intelligently such duties as may arise in the management of a flock. Without such knowledge and understanding, there are no basic principles of guidance and no modern basis for the development of scientifically sound breeding programs. Anatomy,

physiology, genetics, and so on are not extraneous features of science that can be put into or left out of an animal. They are merely separations for the organization of special fields of knowledge. One process does not occur at a time in animals; all processes are simultaneous and continuous.

Sexual maturity. Although there are individual exceptions, most sheep reach the stage of development where reproduction is possible at an age of approximately 4 to 6 or 7 months. The sex organs of males are apparently fully developed by that time, and the so-called secondary sex characteristics which are dependent upon the presence and functioning of these organs are very noticeable. Females are perhaps somewhat later in reaching full sexual development than are rams. However, full development may be reached before the onset of estrus or heat, for in sheep there are long periods (anestrus) when the female organs are not active. The first estrus in ewe lambs of the mutton breeds may occur when from 8 to 10 months of age. In Merinoes it may be delayed until 16 or 20 months.

Male characters. Because the reproductive cells of the male, the sperm or spermatozoa, are formed in the testicles, the testicles are generally considered the primary organs of reproduction of the male. In addition to the formation of sperm cells, the testicles secrete one or more hormones which, absorbed by the body, cause the development of the secondary sexual characteristics. When these features are very marked in an individual, he is described as masculine. Masculinity is in no way associated with the transmission of any features such as color, length of fleece, or other factors of the ram to his offspring. The well-developed, masculine features merely indicate an abundance of the hormone which stimulates the development of the features. The removal of the testicles, and hence the removal of the source of the hormone, results in stopping the development of the masculine characters. This is the reason why wethers differ so much in appearance from rams.

The testicles. The testicles are normally carried outside the body cavity in a sac called the scrotum. The normal temperature of the testicles is below that of the body, and one of the main functions of the scrotum is to regulate the temperature of these organs. This explains the lack of fertility in rams if the testicles are not descended into the scrotal sac. It also explains why some rams that have been heavily fed and therefore may have had an increased



Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

This is a highly magnified cross section of a seminiferous tubule in which sperm are formed.

body temperature accompanied by some increase in scrotal temperature may be sterile. Shearing breeding rams that have been shown or heavily fed may hasten the recovery of the reproductive function of the testicles. The production of the hormone by the testicles does not seem to be influenced greatly by temperature, and hence a cryptorchid or ridgling may appear thoroughly masculine. Rams with one testicle retained within the body cavity should not be used for breeding, as there is a tendency for the condition to occur in succeeding generations, although it will not appear in all cases.

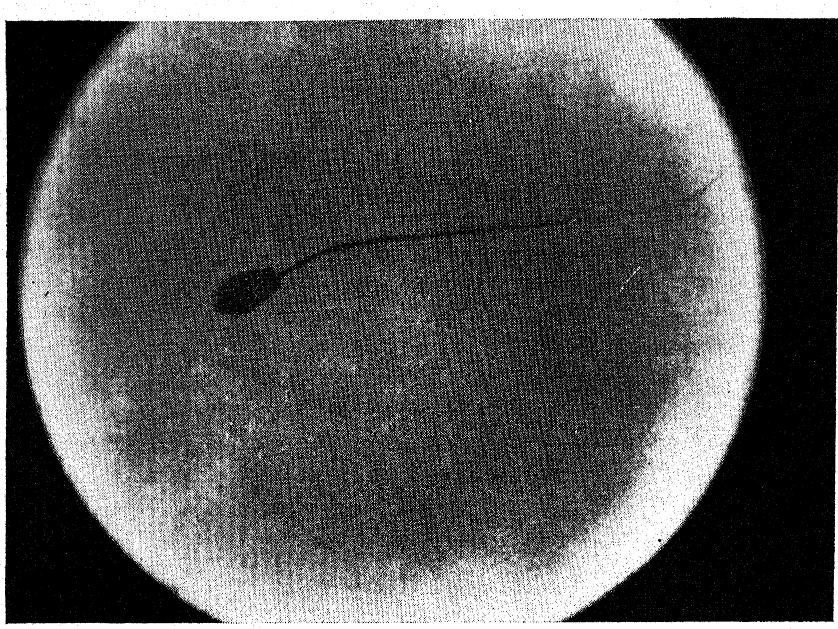
The testicles are covered with a fibrous capsule, the tunica albuginea. Within this capsule are blood vessels, nerves, and connective, interstitial, and spermatogenic tissue. The connective tissue divides the interior of the testicles into very small sections or compartments. In each of these sections are the seminiferous tubules within which is the secreting tissue where the billions upon billions of sperm cells are developed. It is estimated that these tubules are so numerous that their aggregate length would be

many thousand feet. It will be necessary to consider cell formation more in detail in studying the inheritance of characters, but, for the purpose of reproduction, it is sufficient to remember that the contribution of the male to the new offspring originates in the seminiferous tubules. There, spermatogonia or sperm mother cells enlarge and divide. Thus, two cells arise. Both of these divide again. During these processes the cells have moved toward the end of the tubule. Nourishment is provided for the completion of the development. When this occurs, there has been produced a spermatozoa or male sperm cell.

A normal sperm cell consists of a head, body, and tail. The formation of spermatoza is a process which continues from the time it first starts until the end of life in the case of most sheep. The sperm as found in the testicles are not very active. They become active later when they come into contact with some secretions of other glands. Besides carrying the factors which the offspring will inherit from the sire, the spermatozoa initiate cell division on the part of the egg after its fertilization.

There are other important parts of the male reproductive system. Ducts, called efferent ducts or vasa efferentia, formed by the joining of many of the tubules, lead to the epididymis which is essentially a large tube that is found on the outside of the testicles and leads from the top of the testes to the base. The epididymis provides a passageway and temporary storage for the sperm. Ducts leading from the epididymis form the vasa deferentia. These tubes pass up through the inguinal canal—the small opening into the abdominal cavity—and connect with the urethra, which, leading through the penis, completes the passage from the testes to the exterior. In rams there is a small filiform appendage at the end of the penis. This is not, however, a vital matter in reproduction. At various points along this passageway are accessory glands whose chief function seems to be the secretion of fluids which serve as media for the transference and perhaps nourishment or stimulation of the spermatoza. Alongside of the ducts leading from the testes to the abdominal cavity are blood vessels, nerves, and supporting tissues. These are cut or broken when castration is performed. Rupture and separation of the main blood vessel so that blood does not reach the testicle is the basis of bloodless methods of castration. Under such conditions the testes shrink or atrophy.

Not all of the sperm that are formed reach maturity. In many



Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

This is normal sheep sperm x 1173. Sperm concentration in ram semen is extremely high.

individuals there are thousands of imperfectly formed sperm, and many of the sperm have no motility. Infections and above normal temperatures are two factors that are known to affect the sperm cells. Any males that have a large percentage of abnormal or non-motile sperm are likely to be unreliable as breeders, and in severe cases they are sterile. Microscopic examinations of the semen are needed to determine whether such conditions exist.

The semen of rams emitted at one time is from 0.5 to 2.0 cubic centimeters in volume. Very frequent service may reduce the volume as well as the number of sperm that the semen contains. The number of sperm in a cubic millimeter of semen ranges from 500,000 to 6,000,000 or more. The average number per cubic millimeter is probably about 1,000,000 sperm. Since only one sperm is required to fertilize each egg cell produced by the female, the lavish production of sperm is apparent.

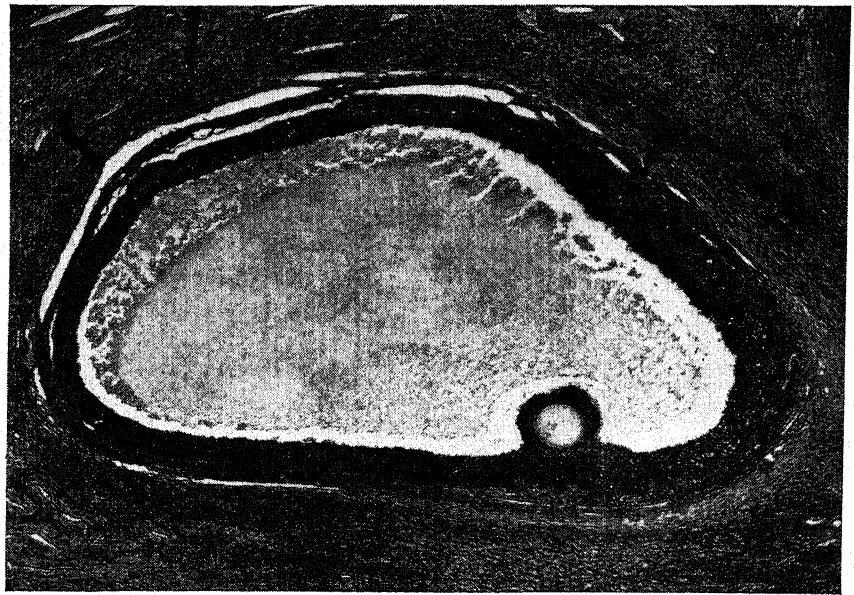
Artificial insemination. It is because of this that the possibility of artificially inseminating females exists. From four to eight

ewes may be inseminated from one service of a ram—although as many as 30 to 40 have been reported, but the degree of success was not given—as 0.1 to 0.2 cc of semen is sufficient for the purpose when there is a heavy concentration of sperm in the semen. Great numbers of sperm are of course needed as they are microscopic in size, and the reproductive tract of the female through which they must migrate to come in contact with the egg, also microscopic, is very large indeed in relation to the size of the reproductive cells. Apparently, most sperm do not survive much more than 18 to 24 hours in the reproductive tract of the ewe. Russian research workers have reported impregnating from 300 to 400 ewes in one season with the semen collected from a single ram. They also reported that 90 per cent of the ewes so inseminated became pregnant. This is a far greater number than could be bred to one ram using natural methods. From 40 to 60 ewes is generally considered a reasonable maximum for a ram in one season.

For the purpose of artificial insemination, artificial vaginas are used for the collection of the semen, although it may be recovered in some quantity from the vagina of an ewe. Semen has been preserved for several days with suitable media and lowered temperature. In this way it has been transported long distances and used successfully in some experimental tests. A method of preserving and transporting semen in gelatin has been reported. When the gelatin suppository was placed in the cervix of the uterus, the sperm were liberated.

Although little use has been made of artificial insemination in sheep except in an experimental way, some of the advantages and disadvantages are known. The chief advantages are that the usefulness of a superior sire may be greatly extended, the number of rams needed for a large flock is reduced, and a flock of considerably greater uniformity should result. Disadvantages include such matters as the need for extra equipment and labor, some of which must be skilled in the work, the need for one or more "teasers" to learn which ewes are in estrus, and the frequent handling of the ewes during the breeding season.

Female organs. The initial reproductive process in the female occurs in the ovaries. The ewe has two ovaries. These, like the testicles of the male, have a double function; they produce the eggs or ova, which are the reproductive cells of the female, and they secrete one or more hormones. The ovaries, about 0.5 to 1.0 inch

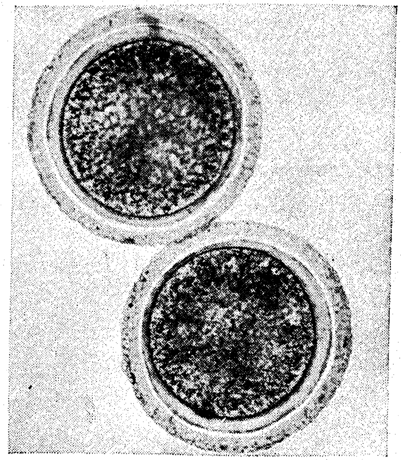


Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

This cross section of the ovary shows the ovum in ripe follicle.

across at the greatest diameter and weighing from 2 to 4 grams, are situated inside the abdominal cavity and are suspended within a broad ligament. The external layer of the ovaries consists of cells, called the germinal epithelium, which give rise to the eggs or ova. The ova are contained in small sacs, ovisacs, or Graffian follicles. In addition to the egg cell, the follicle contains a considerable amount of fluid, especially as the ovum reaches maturity and is ready to be released. The release of the egg is accomplished through the rupture of the sac. This is known as ovulation. In ewes, one or more follicles rupture during each estrus or heat period. If one follicle ruptures and one egg is released and later fertilized, the ewe will produce a single lamb; if more than one is released and all are fertilized and complete development occurs, the ewe will drop two or more lambs. Thus, it is seen that the number of lambs dropped by ewes depends upon the number of ova available for fertilization by the sperm of the male. The ram does not influence the number of lambs beyond the number of eggs developed by the ewe. Assuming two rams of equal fertility, either would get the same number of lambs from a flock of ewes.

Leading from the ovaries, but not directly attached to them, are the Fallopian tubes through which the ova pass to the uterus. The Fallopian tubes are often referred to as the oviducts, as they are the channels for the transfer of the ova. The ducts are suspended in the same broad ligament as the ovaries. The end of the duct nearest the ovary is funnel-shaped to facilitate the entrance of the ovum. The duct is not a straight tube but is rather tortuous and its inner cells very likely have a secretory function which aids fertilization. Within the oviducts too is a ciliated, or extremely fine hair-like, lining. These cilia have a wave-like movement, mainly toward the uterus, which aids the passage of the ovum through the ducts. The sperm of the male pass up these tubes, and it is within them that fertilization of the ova usually occurs. In fertilization the sperm passes into the egg cell. As soon as one sperm has entered the egg, some miraculous change or process prevents any other sperm from entering. The sperm move in a manner similar to tadpoles, but the ova has no means of movement. The fertilized ovum passes down into the uterus where it finds lodgment and continues development. Any unfertilized eggs disintegrate and are absorbed as are the great numbers of spermatozoa that have no purpose after other sperm have fertilized the ova.



Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

This is a pair of ova, apparently fertilized, which upon development and differentiation will ultimately result in lambs.

The Fallopian tubes terminate at the horns of the uterus, which is the largest part of the reproductive tract. The lining of the uterus, or uterine mucosa, is abundantly supplied with blood vessels, glands, and lymph spaces. The uterus is also highly muscular. This muscular structure provides the elasticity for the enlargement of the uterus during pregnancy and also provides some of the means whereby the fetus is expelled at parturition or delivery. At its posterior the uterus terminates in the cervix, or neck,

or os. It is through the cervix that the sperm enter the uterus from the vagina where they are deposited by the ram. The cervix is tightly closed except at estrus or parturition. During pregnancy it is sealed with a mucous plug which serves to protect and safeguard the organ and the embryo from infection. In ewes the cervix is roughly eight inches forward of the exterior opening of the vagina.

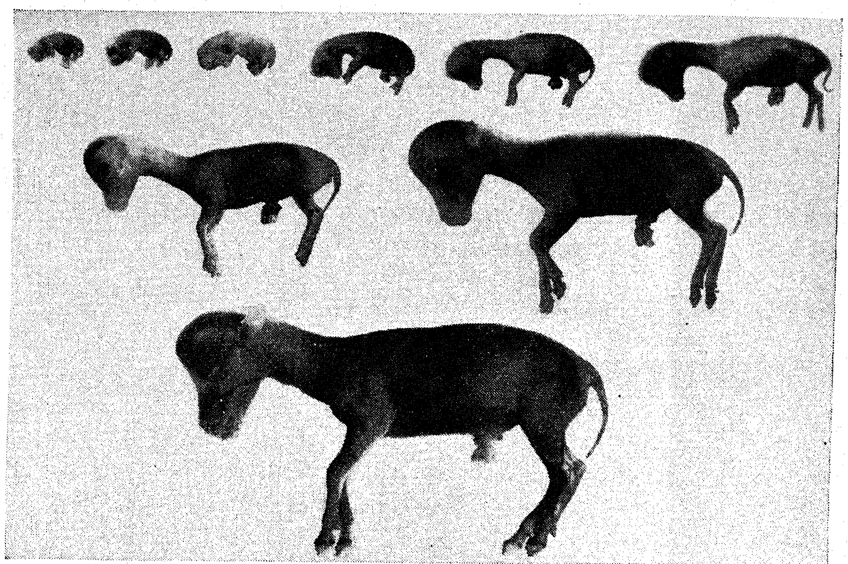
Nourishment for the fertilized egg is provided by its own yolk and very probably by some of the uterine secretions which it absorbs. Soon the egg becomes imbedded or attached to the wall of the uterus, and an envelope or placenta is formed around the egg as it proceeds to develop. All of the inherited features which the lamb will ever possess have already been provided by the sperm and the egg through processes which will be explained later. Nothing except nourishment and the removal of waste materials, along with a suitable place for development, is received from the mother during the embryonic and fetal life of the lamb. The mother does not contribute blood as such to the embryo, for the placenta provides a transportation medium through which the embryo is supplied with the materials by which it develops. The fetus' blood supply is wholly independent from that of the ewe. The placenta, in the case of sheep, is attached to the uterus at a large number of places—75 to 125 or more—by means of "buttons" or cotyledons. It is at these points of attachment that the blood supplies of the mother and fetus come into very close contact. The navel cord or umbilicus, that is familiar to all who have observed the birth of young, is attached to the placenta and not directly to the body of the mother. At birth the placental covering is broken, and the lamb is delivered without this covering. The placenta or afterbirth is cast or discharged by the ewe after the birth of the lamb.

The foregoing is far from a complete and detailed description of reproduction in sheep, but it includes those matters in which the producer is most interested. Though the reproductive organs and their major functions have been sketched, their operation and activities influence many other parts and functions of the body; and there are very significant interrelationships between many other glands and organs and the successful functioning of the male and female reproductive systems and processes. Many of these relationships are at present imperfectly understood, but enough is known of them to impress workers in these fields with their far-reaching importance.

It remains to point out in broad outline some of the more general considerations in connection with reproductive phenomena.

General reproductive phenomena. Sheep have a somewhat restricted breeding season which is limited to a period of about four months, generally in the fall of the year. There are some breeds and some individuals that do not conform to this limited period. The occurrence of heat or estrus in ewes is accompanied in all normal cases by ovulation, which makes the ova available for fertilization. Ovulation has been shown to occur in ewes near the close of the heat period, or since estrus lasts on an average about 24 to 28 hours, ovulation may be said to occur about that length of time after estrus has begun. However, it is altogether likely that the time of ovulation is more closely related to the end of estrus than to its beginning. Since neither the egg nor the sperm have the ability to survive for long periods, fertilization must take place within some hours after ovulation. The variation in the times of ovulation and of the fertilization of the egg, in respect to the time when the ewe is observed as being in heat, may account for some of the variation in the length of the gestation periods. In performing artificial insemination, these facts indicate the desirability of doing the impregnating approximately 20 or 24 hours after the ewe comes into estrus.

Many of the processes which occur after the fertilization of the ova have been studied by physiologists in great detail and are well, although not completely, understood. After ovulation there is formed in the ovary, at the point where the follicle ruptured, a corpus luteum or yellow body. If conception does not occur, the corpus luteum is partially or completely absorbed before the beginning of the next heat period. In fact, such absorption seems to be necessary before the next estrus: in some animals that show irregular heat periods, the persistence of the corpus luteum appears to be chiefly if not entirely responsible for such irregularity. If conception does occur, then the corpus luteum continues to enlarge until about the middle of the gestation period, after which it may gradually shrink and almost disappear by the time of parturition. While this so-called "yellow body" may seem to be of little consequence during pregnancy, the truth of the matter is quite the opposite. The corpus luteum secretes hormones which alone, or functioning with other hormones, are responsible for the successful implanting and early development of the embryo in the uterus, the

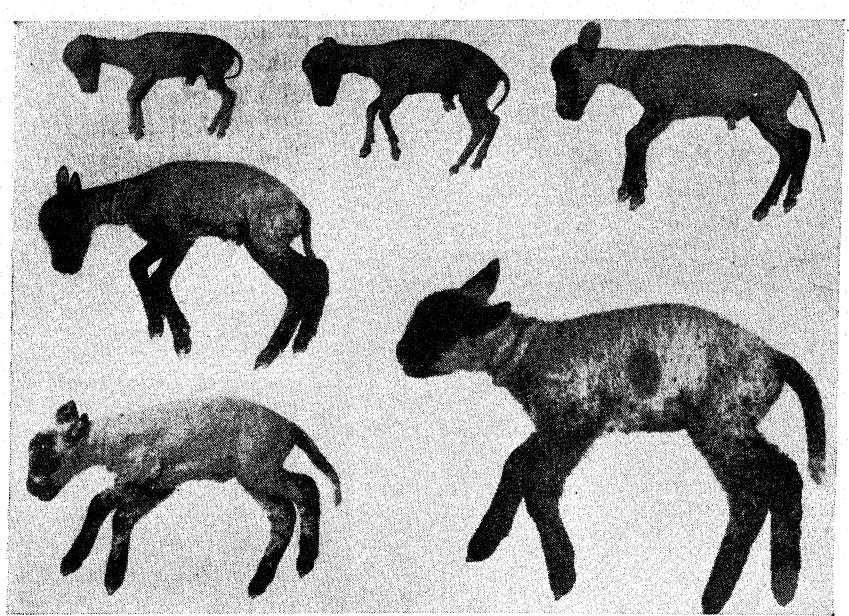


Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

These are enlarged views of a sheep fetus from the beginning of the fetal period at 34 days after fertilization to 74 days: left to right, 34 days, 36 days, 38 days, 42 days, 46 days, 52 days, 58 days, 66 days, and 74 days.

prevention of further ovulation during pregnancy, and for the relaxation of the muscles of the pelvic region as the time of parturition nears. If the corpus luteum does not persist throughout pregnancy, the fetus may be absorbed if still in the embryonic stage; if it is later in pregnancy, abortion will occur.

The development which the fertilized ovum must undergo to result in a fully developed lamb with all its parts and functions normal is indeed a complicated and marvelous process. The lamb consists of many well-differentiated parts, each with its billions upon billions of cells, all of which had their source in the original sperm and egg. How this differentiation is brought about and what causes and directing forces are involved are little known. When the fetus has grown to the point where it can take care of itself, to a very limited extent to be sure, it is released from the interior of its mother and finds suitable food awaiting it in the mammary system of its parent. The mammary glands are properly considered as a part of the reproductive system since their functional activity is stimulated as a result of pregnancy; without the milk which they



Courtesy L. M. Winters, Minnesota Agricultural Experiment Station

The period from 84 days to 140 days shows continuing growth and differentiation: left to right, 84 days, 94 days, 104 days, 116 days, 128 days, and 140 days. Hair appears first in about 90 days, and there is a complete covering of hair at about 116 days.

secrete the lamb would survive but a short time after its birth. The first milk (colosturm) is specially adapted to the nutritional needs of the lamb during its first few days after birth. Lactation continues for a four- to six- or seven-months period, when the mammary secretion is no longer needed by the lamb.

The delicate balance that must be maintained by the body during the reproductive periods is thus illustrated, and the remarkable feature is that success is far more common than failure.

Genetic terms. Modern progressive sheep breeding is based on the facts revealed through the studies of the transfer of characters from parents to offspring. This is the science of genetics. To understand discussions relating to breeding, genetics, and heredity, it is helpful, indeed necessary, to know the meaning and use of certain technical terms. Some, if not all, of these terms should be as much a part of the vocabulary of the enlightened sheep breeder as many other words which are now standard usage, although a

few years ago they were unknown to many people. These technical words may seem difficult and meaningless, but they are as easily mastered as carburetor, fuselage, differential, and others. Because of the importance of these words in an explanation and understanding of the material which follows, they are listed and explained at this point. All of these terms have a wide application, and their use is not restricted to sheep breeding. They will be familiar to those who understand genetics.

Acquired character. Any feature of an animal which is developed as a result of outside influence and is not due to inheritance from an ancestor.

Allelomorph. A character or gene for which there is a contrasting one. White may be the allemorph of black and horned the allel of polled.

Cell. A microscopic living unit composed of various materials such as the nucleus within which are other materials such as chromosomes.

Cell division. Manner of growth through enlargement and division. In most cases, the division results in the formation of more cells that are the same as the parent cells. This is not true in the formation of reproductive cells.

Character. Any feature such as color of face or fleece, horns, length of ear, and so on that is present in the animal. A character may be due to a single factor or gene or to several. This is one of the reasons why it is difficult to know how a particular character developed.

Chromosome. Extremely minute bodies composed of chromatin material within the nucelus of cells. Sheep, like other animals, have a constant number of chromosomes of definite size and shape in each cell. With the exception of the sex chromosomes, the chromosomes are paired; that is, there are two of a kind, but they may not carry the same factors or genes. Two chromosomes of the same kind are called homologous.

Complimentary factors. Two or more factors which together result in a character. Probably a number of features of sheep are due to such factors.

Crossing over. A gene passes from one chromosome to another. This occurs at the time of the reduction division in sperm formation.

Dominance. An hereditary character or factor which de-

velops and hides or masks a contrasting character. The masking may be complete or partial. In most sheep white fleece is dominant to black, and although the factor for black may be present the color is not seen. The factor which is not expressed is called a recessive.

Egg. An ovum (ova) or reproductive cell produced by the female. To become functional and grow, the egg must be fertilized by a sperm cell from the male.

Embryo. The early stages of the development of the fertilized ova in the uterus; in later stages it is called the fetus.

Environment. Any influence that has its origin outside the body. Feed, climate, shelter are parts of environment. This is a continuing influence in contrast with heredity, which is completed at the time of fertilization.

Factor. A gene or determiner of a character; a unit of inheritance. These are carried on the chromosomes.

F_1, F_2, F_3. (Pronounced eff one, et cetera.) The F_1 generation represents individuals produced by parents that are unlike in one or more hereditary factors; F_2 individuals result from mating two F_1s; F_3 individuals result from mating two F_2s.

Fertilization. The uniting of a sperm and an ovum, and consequent starting of a new individual.

Fetus. An unborn lamb.

Gamete. A mature germ cell; a mature sperm or ovum.

Gene. A unit of inheritance. Genes are located on the chromosomes.

Genetics. The science which explains similarities and differences in related animals or organisms.

Genotype. All of the factors which the animal possesses in its germ plasm and which it may transmit to its offspring. Because this is not fully represented by the appearance of a sheep, the breeding performance is difficult or impossible to estimate.

Germ plasm. All of the material basis of heredity considered collectively. Everything in the reproductive cells from the male or the female. Because of the greater number of descendants, the germ plasm of males is considered of more importance than that of females, although both are equally important in the production of any individual.

Heterozygote. An animal which has both genes or factors of an allelomorphic pair; for example, white and black. Impure for a character.

Heterozygous. The condition found in a heterozygote.

Homozygote. The opposite of heterozygote. The genes for any character are the same on both chromosomes of a pair.

Homozygous. Pure for a character. The condition found in a homozygote.

Hybrid. The result of mating two unlike or unrelated animals. In this sense the offspring of a Southdown and Rambouillet is a hybrid, although usually called a crossbred by sheepmen.

Hybrid vigor. When hybrids exceed either parent in rate of growth or size at maturity, this is ascribed to hybrid vigor or heterosis. It is not uncommon in sheep.

Identical twins. Two individuals resulting from a single fertilized egg and identical in all heritable characters. Apparently rare in sheep.

Inbreeding. Mating animals that are closely related.

Lethal factor. Any factor which kills a germ cell, embryo, or fetus.

Line breeding. A system of mating designed to keep the descendants closely related to an ancestor regarded as very desirable.

Linkage. Factors that keep together in inheritance because of being located on the same chromosome.

Multiple factors. Two or more factors that give a single result or a similar effect.

Mutant. The result of mutation. Differing from ancestors because of a change in germ plasm.

Nucleus. That part of a cell which controls its activities and contains the chromosomes.

Phenotype. The appearance of an animal with respect to characters it inherited and as affected by environment. It may contain other characters in its germ plasm that differ greatly from those which it displays in its own make-up.

Prepotency. Usually used with reference to males and signifies an unusual ability to transmit his characters to his offspring regardless of the kind of females with which he is mated. From a genetic standpoint it implies the possession of many dominant factors which overshadow the characters of the females.

Progeny. The produce of an ewe; the get of a ram; offspring or descendants.

Recessive. The opposite of dominant. Recessive characters

are hidden when dominant factors are present. When the recessive character is seen, genes for such a character were received from both parents, and the animal is pure or homozygous for that character.

Reduction division. One of the divisions of cells in the formation of a sperm or ovum when the number of chromosomes is reduced to half the number in other cells. At fertilization the union of the chromosomes of the sperm and egg restore the usual number of pairs of chromosomes.

Reversion. An animal reverts when it displays a character possessed by some remote ancestor. Reversion may be due to the coming together of recessive characters.

Segregation. When the reduction division occurs, the allelomorphic factors or genes are separated into different cells. Thus, the gene for horned would be separated from the gene for polled and would be carried in different sperm or ova.

Sex chromosome. Often called X chromosome. They are especially involved in the determination of sex. One sex, the female in sheep, has two X chromosomes. In the other sex the X chromosome may be paired with one differing in some ways and called a Y.

Sex limited. The character can be expressed only by one sex.

Sex linkage. Any factors or genes carried by the sex chromosomes.

Sperm or spermatozoa. A mature germ cell of a ram.

Telegony. An effect that a sire that had been mated with a dam was supposed to have on the later progeny of the dam even though the progeny was by another sire. Such effects do not exist.

Zygote. A fertilized egg or an individual resulting from it.

Mechanism of inheritance. The mechanism of inheritance is, of course, based on reproduction. The initiation of the reproductive process and the transmission of characters from parents to offspring are simultaneous processes. The processes by which the sperm cells and the egg cells are formed as the initial steps in the reproductive function were mentioned briefly. It was stated that sperm and ova arose from the process of cell division within the testes and ovaries. Now it is necessary to refer again to the reproductive cells of both the male and female in order to get an understanding of how characters are transmitted from parent to offspring. All of the body cells of sheep are believed to contain 60

chromosomes. These chromosomes are arranged in the cells in pairs. Since the cells themselves are microscopic and since the chromosomes are contained with the cells, their minute size will be appreciated. The reproductive cells differ from the other body cells. One of the greatest differences is in the number of chromosomes which they contain.

The sperm cell contains one half the number of chromosomes found in the body cells. The egg cells supplied by the female also contain half as many chromosomes as the other cells of the body. This reduction in chromosomes within the reproductive cells is brought about in the formation of the sperm and ova. It is not necessary to describe the process in detail, but it is important to know that such a division of chromosomes does take place in the elaboration of sperm and ova. The reason for this concern regarding chromosomes is that they carry all the heredity characters. Each gene is responsible for some character or a part of one or more characters that are transmitted from parent to offspring. Each chromosome of a pair has similar genes, although the characters which the genes cause in the offspring may be different.

No one knows how many genes there are on any one of the 30 pairs of chromosomes. If there are only 10, that would mean the 30 chromosomes in each sperm and the 30 in each ovum carried the factors that determine 300 of the characteristics of the offspring of a ram and a ewe. The actual number of genes is undoubtedly much greater. If the chromosomes from the male and those from the female have within them genes for the same characteristics, the lamb will be pure or homozygous for those characteristics when the chromosomes unite to form body cells with twice as many chromosomes as found in the reproductive cells. But, if one gene for color, for example, on one chromosome is for white and the gene on the other chromosome from the other parent is for black, then the lamb is not pure for white color, although it may appear white. In such cases the geneticist terms the lamb heterozygous for color. Exactly the same thing may be true for all characteristics where it is possible to have one condition or another or even where there may not be such absolute differences as there are between white and black or horned and polled.

Referring again to chromosomes carrying the factors for white and black, it is important to remember that if those two colors were received from the parents. one chromosome in the cells of the lamb

Courtesy D. S. Bell, Ohio Agricultural Experiment Station

It is an unusual occurrence when a Shropshire ewe has three black lambs. The black factor came from both sire and dam.

will carry the factor for white, and the other chromosome will carry the factor for black. In the subsequent formation of reproductive cells, at the point where the reduction of the number of chromosomes occurs in that process, one cell will receive the chromosome bearing the factor for white, and the other will receive the chromosome carrying the factor for black. Both, of course, come from the same parent. Hence, it becomes immediately apparent that identical parentage does not insure identical inheritance. If both chromosomes carried the same factor, then inheritance would be identical for that character.

Do you wonder why it is so difficult to find two animals that are exactly alike? If the case of white and black is followed further, it will become plainer and still more evident as other factors are added. Suppose a ram and a ewe, both heterozygous (not pure for either white or black) for color, are mated. In the first place each of them can produce two kinds of gametes (reproductive cells) with respect to color. One gamete would carry the factor for white; another would carry the factor for black. These two kinds of gametes are capable of producing two kinds of lambs with respect to their

color appearance. They may be white or black. But there will be three kinds of lambs with respect to their genetic make-up. White is dominant over black, and there may be lambs that are pure or homozygous for white, heterozygous for white and black, and others that are pure for black. Since black is a recessive color in most of our common sheep, only lambs that are pure for black have a black color. Thus, if a black lamb is born it gets that character equally from both parents.

The same processes are involved with respect to all characters that are due to single genes. If a ram was homozygous for all characters he possessed, his offspring from ewes that had dissimilar characters could not possibly be homozygous. Thus, the only way to maintain a homozygous condition once it has been developed is to restrict mating to individuals that are similarly homozygous. Mating brother and sister does not in itself insure progeny that is homozygous.

Even with a homozygous condition with respect to the genes, it would be unwarranted to expect all progeny to be exactly alike, for some characters that are to be found in individuals are due to physiological reactions, which of course may in turn be related to the genes which have been transmitted from the parents. Horns are undoubtedly an inherited character, but certain physiological processes or substances must be present for the inheritance to become evident. The interference with such processes by means of castration interferes with the appearance of the character. Very likely other characters are equally affected by physiological processes. And it is altogether possible that physiological processes are influenced by the interaction of various genes.

Although some characters are due to single genes, not all characters are. Some are due to two or more genes where the degree of interaction may vary. Dominance may not always be complete, and partial dominance introduces more complexity. Likewise, there are cases where a character may be dominant in one sex but not in the other.

Genetics and sheep breeding. There have been relatively few distinctly breeding experiments with sheep where the object was to study the heritability of characters of economic importance, but those which have been made seem to have considerable significance. Among such efforts is the work of the South Dakota Experiment Station in developing a short-tailed breed so that the necessity

of docking would be eliminated. The short-tailed character seems to be a recessive factor, although the long tail does not appear to be completely dominant.

The work of Alexander Graham Bell indicated the possibility of developing functional teats in addition to the usual two. He found the conditions strongly inherited. He also found a short or earless condition to be a recessive character. Others have shown that both "undershot" and "overshot" jaws are transmissible characters and are apparently due to recessive factors. Cryptorchism is also a transmissible character. Twinning is so subject to the influence of environment that no definite heritability has yet been established. Horns in sheep apparently represent a rather complex pattern which does not seem to be the same for all breeds. In a few breeds, notably the Dorset, both sexes have horns; in Merinoes and Rambouillets the rams have horns although there is a polled strain also, and the ewes may range from hornless to mere stubs, or some may show horns several inches long. Castration usually stops horn growth in Merino and Rambouillet males but only reduces it in Dorsets.

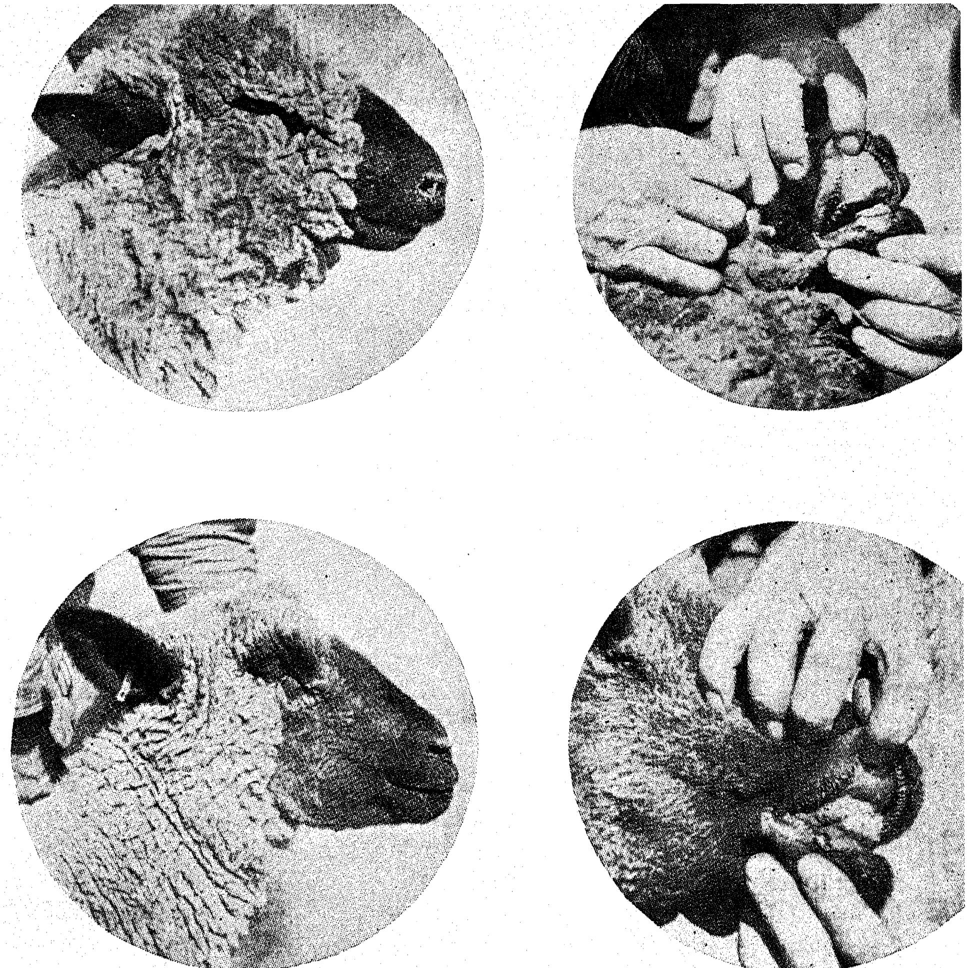
In spite of the fact that to date genetics has played but a small part in the breeding of sheep, there have been enough studies now to show that it will likely be much more important in the future. The methods and practices of the past have accomplished much and have given us the fine individual specimens we have at present, but with these methods it is likely that further progress will be very slow, and the best that can be hoped for is to hold the gains that have been made. None of these methods offer much hope for great uniformity of excellence throughout a flock and the continued maintenance of excellence in numerous animals. Much of the measure of success in breeding sheep has been based on the production of one or two exceptional animals. These exceptional animals have been appraised on the basis of their appearance and its conformity with a rather arbitrary standard of excellence. There has been no account taken of the economy with which that excellence was secured or of the ability of the animal to reproduce similar excellence in its offspring. The uninterrupted, economical production of highly desirable products with great certainty from generation to generation is likely to be the goal of the future sheep breeder. To accomplish this he will need the help of the geneticist.

Excellence in the future will probably be based more and

more upon utility in large numbers rather than upon striking appearance in one individual. It is probably safe to say, although there are no substantiating records to prove the point, that our best animals now are produced with about the same degree of regularity that was true in the time of Bakewell, who is generally regarded as one of the first improvers of sheep. Many writers have deplored the failure of Bakewell to leave a record of his "secret," but it seems very probable in the light of present-day facts regarding reproduction and heredity that he could have had no great knowledge of breeding that he could impart to others. He did popularize inbreeding to a certain extent, and this method is used with much caution by some breeders of today. His emphasis on selection of the best and of breeding the best to the best has, however, outlasted any other practice which he used. With this as a basis "pure breeds" were founded, but any breeder who is at all honest will admit that in many cases of mating like to like and best to best he has been unable to produce constant or regular improvement. Selection must continue to be the basis of breeding operations, but the basis of selection can rest on a far more reliable foundation than the appearance of an animal.

These bases are the contribution of genetics to sheep breeding. The geneticist finds far more required for purity than that an animal be a member of a group known as purebred. To the geneticist purity means homozygous with respect to the characters found in the germ plasm, and the only way in which such purity can be maintained is through the continuous mating of sheep all of which are homozygous. Sheep may be homozygous for desirable or undesirable characters, and only through the production of sheep that are pure for many desirable characters does the geneticist see progress. "Purebred" does not mean much to the geneticist when so many different types are to be found in ostensibly purebred flocks, even though these are admittedly nearer to a homozygous condition than the grade flocks whose inheritance has come from a great variety of ancestors.

Economic features. The only present known way of ascertaining whether any degree of purity of germ plasm exists is by testing sires and dams. Emphasis should, of course, be placed on those features that are of economic importance. Such matters as are frequently emphasized by producers of purebreds, such as size and shape of ear, slight differences in extension of wool about the head,



Courtesy J. E. Nordby, National Wool Grower, February, 1931

Malformation of the jaws should be avoided in breeding sheep. The two most common defects are (top) parrot or overshot mouth and (bottom) the opposite undershot condition.

and other similar items, should be shifted to the far background, and preference given to livability, prolificacy, milk production, wool production, meat yield, and economy in the use of feed, together with adaptability to local conditions.

There are many misconceptions and fallacies associated with breeding. This is not surprising when the extremely complicated processes involved are understood. In fact, it would be as great a fallacy as any to believe that we now have all the necessary knowledge to enable us to produce sheep of outstanding merit with regu-

larity. But there is a much sounder basis for explaining away the culls that are sometimes the result of mating like to like. Full use of the scientific knowledge that has been developed will not prevent all mistakes in breeding sheep, but it should make them fewer and certainly will afford the breeder a far sounder foundation for the practices he uses than he could possibly otherwise have. It will require a long time for such knowledge to become diffused among breeders, for many of them do not have the training needed to understand the language that is employed by the geneticists. The practical breeder unable to comprehend this material will, of course, continue to believe that which he can understand, although it may be fallacious. Furthermore, the producer of purebred sheep cannot be expected to be overzealous about the scientific approach to breeding, as it may destroy some of his most cherished beliefs and cast some doubt upon the value of a show sheep as a breeder.

Shows and breeding. Nothing in the foregoing is intended as a reproach to the breeders of show animals, for they have their living to make the same as others. Shows have played a prominent part in the sheep industry and represent a definite phase of the business. But there has been ascribed to shows and showing many attributes that they do not possess and functions which they can in no wise fulfill. There have been many things about shows that have not been in the direction of making sheep or other animals more profitable for farmers. Show awards have been one of the great advertising mediums, and most of the advertising value accrued to those breeders who showed a champion. With the general belief that like would produce like, it was natural to expect the champion to produce the best-looking progeny, and it made no difference what the expense of making the champion a champion was. Totally uneconomic points were carefully weighed and were often considered as points of great excellence. Furthermore, much of the special merit of the best show sheep was due to skillful feeding and fitting and was therefore in the realm of environmental influences or acquired characteristics that were not transmitted to progeny. In appraising methods, it must not be overlooked that much of the excellence of the best sheep is attributable to improvement in environment that has been an accompaniment of breeding.

There is fear on the part of some breeders that the application of the principles of genetics to sheep breeding will make the normal breeding program so complicated that such application cannot

become popular. It is doubtful if this will be the case. The same views were held with respect to many of the practices which are now accepted as standard by many producers. The thing that matters is whether the rams and ewes which are chosen as breeders get superior stock with respect to economic factors. The principles of genetics give an acceptable explanation of some of the more difficult problems of sheep breeding. Likewise, the use of these principles should make it possible to reduce greatly, and at much greater speed than has been true to date, the extreme variability seen even in the purebreds. The production of an outstanding individual, which may or may not breed true, is a far different ideal than is the production of animals which are true-breeding and homozygous in fact.

Systems of breeding. In general there have been three systems or methods of breeding. These are frequently listed as mass or random breeding, inbreeding, and line breeding. It is, however, possible to refine the classification to a greater degree, as Lush [1] has done. He lists random mating as bringing together individuals that are no more or less alike either as individuals or in their ancestry than if they had been drawn by lot. A second method of mating like to like on the basis of pedigree would include inbreeding, line breeding, family breeding, et cetera, or it might be on the basis of individuality such as big with big, small with small, and so on. The third method would be the mating of unlikes and, on the basis of pedigrees, would involve crossbreeding, outbreeding, or the crossing of strains within a breed. Based on individuals, this would call for the mating of extremes, such as large and small, rangy and compact, with the idea of producing intermediates.

Mass selection. Mass selection and mass or random breeding can never do more than maintain the heterozygous character of our sheep. This will result in the continued appearance of unwanted, undesirable animals. Many of the undesirable traits of sheep appear to be recessive. The heterozygous condition cannot be eliminated merely by selection. Selection and mass breeding will therefore probably continue the breed-average but is very ineffective in improving it. The breed-average is the result of many measurements that are scattered more or less regularly above and below the central figure. Domestic sheep, like other animals, are a complex of many thousands of gene effects, and there are

[1] J. L. Lush. Animal Breeding Plans. p. 99.

vast numbers of different combinations possible as well as many different degrees of environmental influence. Selection on the basis of appearance alone, as is the case in mass selection and mass breeding, is not likely to give the best breeding animals.

Progeny test. A progeny test would give at least a partial basis for selection on gene type and would be a more reliable foundation. This would tend to eliminate selection of individuals whose attractive characters were due to a large extent to the effects of favorable environment. The progeny test is therefore an alternative to selection on the basis of appearance alone. No one can proclaim that he has a first-class sire until he has been tested by his progeny. Progeny testing too is the exact opposite of pedigree selection, although the two may be combined. Living descendants are far more important than dead ancestors. There are, however, some limitations to progeny testing, for an offspring is not the progeny of the sire alone, but has received one-half of its inheritance from its dam. It is important also to have enough progeny so that the effects of environment will not be overemphasized. Progeny testing is an aid in accurate selection, but it may not be the final answer.

Inbreeding. Inbreeding is the quickest way of increasing pure breeding strains within a breed because the reduction in the number of ancestors means there will be less variation in future generations. The closest inbreeding, such as brother-sister matings, is not often possible in sheep, for many of the best rams whose characteristics one would wish to perpetuate and concentrate may not have more than one or two full sisters. The mating of two pure or homozygous parents is the only way to maintain that purity with respect to genetic factors. If two animals are mated, each being pure for different factors, the offspring carries a greater number of different hereditary factors than either parent. Thus, it would seem wise that breeders should endeavor to preserve and utilize by inbreeding the excellent qualities of every outstanding animal that appears. This is the only way to effect the maximum concentration of the blood of such sires. This would give the closest approach to homozygous animals within the purebreds. It is likely that the requirements of future breeders will be for such strongly inbred animals. Because our purebreds of today possess considerable numbers of undesirable characters, inbreeding is certain to produce some worthless or undesirable offspring. These must of

course be eliminated. Experiments with laboratory animals seem to show that such offspring are in reality due to the essential hybrid nature of the parents. Although the commercial producer wants the most profitable type whether hybrid or not, the breeder wants sheep with as many true-breeding or homozygous characters as possible.

Inbreeding, however, is not without its risks, even though it may bring distinction. If the original stock is very well supplied with defects and poor performance, these will appear in such abundance in the offspring as to require culling that is so drastic that it is not feasible. These undesirable features are revealed even when inbreeding is not followed, but the number of offspring that reveal them to a great degree is reduced. It is not the method of breeding which is solely responsible for good or bad results. Rather, it is a matter of particular genetic factors which the animals used in any system of breeding are carrying. It is at that point that one discovers the essence of the message of genetics for the sheep breeder.

Recessive factors that have undesirable effects have more chance of appearing when inbreeding is followed because there is less chance of a dominant allellemorph being present and thus keeping the undesirable recessive out of sight. But it is equally certain that close breeding increases the possibility for homozygosity for desirable genes, either dominant or recessive. Inbreeding may require drastic culling while the undesirable factors and variability are being eliminated. Despite any handicaps which may develop as a result of inbreeding, the method has been one of the means whereby improvement has occurred.

Line breeding. Random mating and inbreeding are at extreme ends of methods of breeding. Within the limits of these extremes are many degrees of relationship with respect to matings. Breeders who dislike either extreme may resort to a method which is referred to as line breeding wherein an effort is made to maintain a close relationship to some prominent ancestor. Parents that are related to the desired ancestor, but which are not very closely related to each other, usually constitute the basic pattern of line breeding. In the course of line breeding it is necessary from time to time to direct the matings so that as the ancestor becomes more and more remote, a more immediate one takes his place. Line breeding always implies emphasis on a particular ancestor, al-

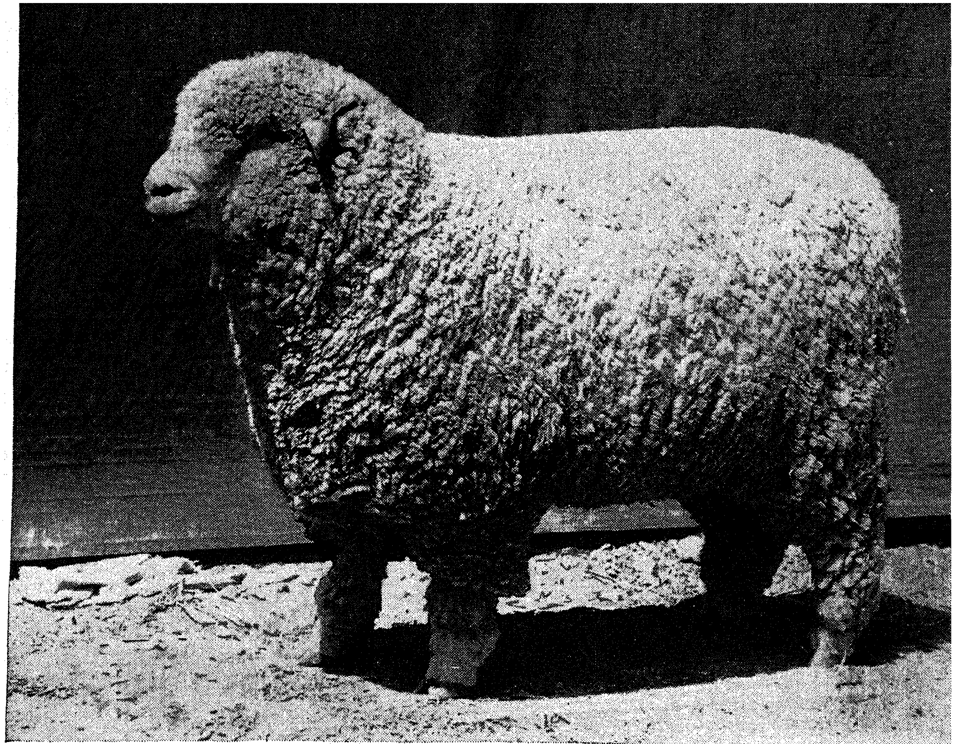
though that ancestor may be emphasized less so that one of his prominent descendants may be emphasized more.

Line breeding, like the other methods, has been used by leading sheep breeders. It has been an effective agency in efforts toward improvement and has been relied upon as an aid in fixing the type of many present-day breeds. In many such cases these men, however, relied upon particular strains within the breed rather than upon a deliberately planned system of line breeding as it is now defined.

Line breeding is a means of building up more or less uniform groups or families and of reducing the rate at which the influence of a prominent ancestor may be diluted or disappear. Line breeding allows for considerable selection and can therefore be used along with this practice. There is little need for line breeding in any flock which does not have many individuals above the average quality of other breeders. Mistakes in selection would be serious in line breeding, especially if it involved mistakes in the selection of the ancestor and the individuals descended from him. While it is generally the practice to line breed to a male ancestor, this is not necessary, although there are great differences with respect to the number of immediate descendants available from a ram compared with a ewe.

If there is much undesirable inheritance in the flock, there is considerable risk in line breeding, although it may not be so great as with inbreeding. There would seem to be little need for the producer of grade sheep to either line or inbreed, although both methods have been used after crossbreeding radically different strains or breeds in efforts to develop new breeds.

Outcrossing. Outcrossing is practiced from time to time by many breeders who have a flock of closely related individuals. To make the outcross, a sire is usually selected from another flock that has some desired characteristics and may have some similarity of bloodlines. This might be called a "mild outcross" in contrast with another which would be considered more "violent" because there was no blood relationship or such relationship was far removed or very slight. Breeders sometimes have preferred strains for outcrossing, as they are believed to "nick" better than other strains. Outcrossing is generally resorted to as a means of securing increased vigor or to introduce one or two features. After the outcross is made, the breeder may return to other methods of breeding.



Courtesy A. C. Esplin, Utah State Agricultural College

A number of present-day breeds originated through crossbreeding. The Corriedale is one such breed.

Crossbreeding. Crossbreeding is very extensively followed in commercial sheep production. It consists in mating either purebred or grade animals of two distinct breeds. Often, purebred rams are mated to grade ewes of another breed for the production of market lambs. There are usually good reasons for such practices, although efforts have been made to develop breeds which would eliminate the need for crossbreeding. In the case of purebreds, much crossbreeding has been for this purpose. Some degree of success has attended these efforts, and there are now a number of breeds that have resulted from crossbreeding. Crossbreeding in sheep has not been so greatly different in some cases from the practice of producing hybrid corn. A breed that had some desirable features such as fine-wool and flocking tendencies, such as the Rambouillet, has been crossed with another that had more pronounced meat-producing ability, such as the Hampshire. Most of the offspring, both male and female, were sold and new breeding stock bought as needed.

This practice was and is followed because there are few breeds or types that possess all the features needed or desired in present-day sheep production. This has been true to so great an extent because of the dual products required of sheep, as well as certain other characteristics necessary to meet localized conditions existing in an industry covering so diverse territory.

There is much crossbreeding on the western ranges, but it is also a common practice in other areas. The production of "hot-house" lambs in the eastern states is usually based on the Southdown sire and grade Merino or Dorset ewes. In Kentucky and other areas many grade Hampshire ewes are mated with Southdown rams. These ewes are generally crosses of fine-wooled ewes and Hampshire rams that have been raised in the West, but such crossbred ewes are not considered widely useful in the West. Crossbreeding in the West is used to get large, fast-growing lambs that will attain a good market finish on the range vegetation or that can be sold to surplus feed areas for finishing. Difficulties in herding medium-wool types and breeds that do not have some fine-wool background make medium-wools more or less unsatisfactory. Other reasons, such as hardiness and shearing qualities, are important too.

Crossbreeding is still extensively practiced in England, New Zealand, and many other countries. It is likely that it will continue to be one of the mainstays of sheep raisers. It would not be so if there were not such great differences with respect to the demand for the products of sheep. This demand is not such that one particular type or quality of product can be sold and others cannot. Thus, the producer is able to dispose of his product even though it is not all of one class or grade.

It seems reasonable that future efforts in breeding will place increased emphasis upon those features that relate to the efficiency and economy of production. This will in some areas involve efforts toward greater prolificacy. In others no greater prolificacy will be wanted, but there will be emphasis on livability and hardiness. In all sections there will be efforts to develop better adapted strains and probably there will be less reliance upon strains that are more highly adapted elsewhere.

CHAPTER 26

★ *Breeding Season Practices* ★

The management of the flock is usually divided into periods. Since the production of the lamb crop, one of the most important crops obtained from sheep, is begun with the breeding season, this appears to be a logical starting point. The objective of the caretaker at this season of the year is to handle the flock so that all of the ewes conceive during a relatively short period and to do those things which contribute to a large lamb crop. Of course, the ram must be given equal attention with the ewes.

During the breeding period in most flocks, the ewes will be maintained chiefly on pastures. Nutritious pastures for use at that time afford the cheapest and the most natural breeding grounds for them, and there is no handicap to success in this method. The exercise the flock obtains in this way undoubtedly contributes to the well-being of its members. The vigor of the ewes and ram are items of importance and must not be overlooked. "Flushing" by providing extra feed or excellent pastures is emphasized in the discussion of feeding. While there are reports of studies which show benefits, there are others which do not substantiate all claims made by the advocates of the practice. Careful thought will reveal the difficulties of securing proof when the reproductive processes involve so many interrelationships. Despite the controversial status of the question, careful flockmasters will try to have the flock in reasonably good flesh at breeding time. A very fat condition is probably more detrimental than a very thin condition, but both should be avoided.

Choosing breeding season. There are some facts about the breeding season that should be well known by all who raise sheep. Although the season at which ewes will breed varies with localities, it is chiefly in the fall of the year but may range from June until about January. It also varies with the breed of the sheep being considered. Dorsets and fine-wool ewes usually breed considerably

earlier than those of the other breeds. Since there is this variation, the time the operator chooses to have his lambs born is the deciding factor.

A rather varied group of factors is involved in choosing between early or late lambs. Usually early lambs are those that in the Central States are dropped in the months of January, February, and up to about the middle of March. Generally, lambs born in April and May are thought of as late lambs. Some sections, such as California and Kentucky, have become known as early-lamb-raising sections. In the former many lambs are dropped in November and December, in the latter, in January and February. "Shed lambing" in the latter months is also common in Idaho, Washington, and other northwestern states.

Controlling estrus. Often producers want to do something to induce their ewes to breed earlier. There is a rather widely held opinion that the onset of the breeding season is dependent upon the coming of cool nights in the fall. There is no really good evidence in support of this, however, for if there were no other factors that influenced it, then all breeds would react in the same way, and those sheep maintained in cool areas would breed at almost all seasons. A small amount of work regarding the matter has been done, and ewes that have been placed in cooled quarters during the summer have not responded differently from similar ewes not so treated.

It has been suggested, too, that the breeding season is controlled by the intensity of light, for Hammond [1] states that the "beginning corresponds with the change from above to below about 13 to 14 hours of daylight." However, there are ewes which breed when this is not the case, and a corresponding period of occurrence does not mean the control of one event by the other. It is likely that this idea is based on the fact that ewes transferred from north to south of the equator change over to a corresponding breeding season. To date this theory has not been thoroughly studied.

Feeds may have some effect on the tendency of ewes to breed earlier than usual, but thus far no great assurance can be attached to the use of any particular feed. Wheat germ oil has been advocated for this purpose, but it has not been proved effective.

Gonadotrophic stimulants have been used and some success reported. Estrus has been induced by the use of oestrin or prolan,

[1] J. HAMMOND. Iour. Agr. Sci. [England] Vol. 34. No. 2. 1944.

a hormone found in the blood of pregnant mares. In some cases ovulation occurs without the manifestation of heat, but some investigators report that a second injection of the material at a 16-day interval results in heat and ovulation and conception if the ewes are bred to a fertile ram. There are some reports that one injection was sufficient if the ewe was artificially inseminated at the right time after the injection. Ovulation occurred 36 to 48 hours after the injection.

It is possible to increase the number of follicles that will ripen in the ovaries at one time by injecting a follicle-stimulating hormone that is found in the anterior pituitary gland. It is said that daily injections for 3 to 4 days before estrus and an injection of prolan during estrus, followed by mating, resulted in 5 embryos being found in the uterus. These processes have not at this time been developed to the point where they are of practical use. But the studies do provide some further information on the physiology of reproduction.

Features of estrus. The duration of estrus in 1,235 cases observed [1] ranged from 3 to 72 hours and averaged 29 hours. Approximately 80 per cent were within the range of 17 to 43 hours. Ovulation seems to occur late in the heat period, usually from about 24 to 30 hours after the beginning of the period.

The interval between estrus periods in 1,038 cases that were closely observed [2] averaged 16.7 days, and 938 of them were in the range of 14 to 19 days. There is some difference among breeds, and ewes kept on a low plane of nutrition had a shorter breeding season but longer estrus periods and lower ovulation rates than similar ewes on a high plane of nutrition. Since fertility is determined largely by the number of eggs shed, and since this may be influenced to some extent by the state of nutrition, there is a logical basis for the practice of flushing. Ewe lambs usually come in heat first when about 8 to 10 months of age. The estrus periods may not be so regular or continue for so long as in older ewes.

Breeding practices. Several practices are important during the breeding season.

Tagging. Tagging is the removal of tags or locks of wool and dirt about the dock. The ewes should be tagged if necessary in preparing for the mating season, but this should involve relatively

[1] Mo. Agr. Exp. Sta. Res. Bul. 264.
[2] Growth, Vol. 3. No. 3.

few ewes, for the flock has not been properly handled if there are many ewes that need such preparation.

Record of dates. Some managers keep a record of the breeding dates of individual ewes. This may be facilitated by stenciling or stamping numbers on their sides. A branding fluid should be used for this purpose. Ordinary paint should not be used because of damage to the wool. Of course, a record of the ewes' numbers and the ram each is bred to is imperative if purebreds are raised.

Checking on ram. Some effort should be made to make sure that the ewes or at least most of them are bred, for it is very disappointing to come to lambing time and find that few or perhaps none of the ewes will lamb because the ram was infertile. If the ewes return in heat regularly there may be wisdom in getting another sire, although, as pointed out earlier, a "shy-breeding" ram may recover fertility as the season advances. Some few men follow the practice of marking the brisket of the ram every day with a non-drying oil and coloring material so that the ewes that are bred will have the color showing on the rump. Usually no material of this kind is used during the first 17 days. Then the color is applied. A different color is used at the beginning of each subsequent 16- or 17-day period. Lubricating oil and ochre of different colors may be used for this purpose. A rather thick mixture is best. Some efforts to use marking harnesses on rams have not been successful.

Ewes per ram. It is a common practice to use a ram on about 40 ewes, although the number varies with the age and condition of the animal. In some larger flocks the practice is 3 rams for each 100 ewes. If one uses a "teaser" to find the ewes that are in heat and then follows the practice of hand coupling, a ram may be used on a much larger number. An "apron" is tied on the "teaser," and he is thus prevented from breeding the ewes. It is a good plan to reserve some of the rams if several are to be used and turn one-half or two-thirds of them in at first. The others are turned in after 16 or 17 days. The ram should be well fed and kept in medium flesh. No supplementary feed is provided for range rams or those on good pasture.

Trimming the feet. Trimming the feet of the rams and shearing them if they are very heavily wooled are practices that should not be overlooked. Rams may be seriously affected by high body temperatures. Shearing is a means of "cooling out" rams.

CHAPTER 27

★ *Developing a Productive Flock* ★

The producing abilities of sheep vary widely. Sheep should be of a type that yield products which meet market requirements. Within any breed or flock there are ewes that consistently raise better lambs than other ewes raise. Not only do some ewes raise better lambs, but they have more twins, and their yearly production is much above ewes that produce only singles. The pounds of lamb that a ewe produces is dependent upon her prolificacy, her milk yield, the livability and growth of the lambs. These are all related to feeding and management, but sheep differ in their response to these items.

Prolificacy. What determines prolificacy or fecundity? The number of lambs dropped depends first of all upon the number of ova (egg cells) liberated by the ovary at the heat period. If only one ovum is released and fertilized, a single lamb will be produced unless this ovum should divide so that twins result. This does not seem to occur with much frequency, and it is undoubtedly true that most twins are due to the fact that two ova (three in case of triplets) are liberated at the same time; all are fertilized and complete their development. Some data already given show the frequency with which this occurs may be associated to some extent with age and size.

Breed also seems to have an effect. The figures below indicate that the medium-wool, mutton-type breeds are more prolific than the Rambouillet, or conditions were more favorable for the former to show their natural fecundity. Feeding at mating time may, by providing an abundance of essential nutrients, have an effect upon the number of ova released for fertilization, and an increase of as much as 18 per cent in lambing percentage may be obtained.[1] It is also said that the time of mating with respect to the breeding season may also influence the number of twins. This is based on

[1] U.S.D.A. Bul. 996.

some observations showing that more twins are born in the first half of the lambing season than in the last half. This may be considered on the basis of time or on the basis of one-half of the lamb crop.

TABLE 11

LAMBING PERCENTAGES FOR VARIOUS BREEDS

No. ewes	Breed	Per cent lambs dropped
853	Rambouillet	122
566	Shropshire	149
1,406	Hampshire	144
310	Oxford	152
516	Southdown	151
781	Dorset	158
146	Lincoln	157
281	Cotswold	144
268	Tunis	141

Are ewes born as twins more prolific than those born as singles? To establish this requires large numbers. A study [1] on almost 19,000 Shropshires recorded in the Shropshire flock book showed that in general parents born as twins tend to have a larger percentage of twins than parents born as singles. Data [2] reported for a group of Cheviots showed dams and daughters produced as follows:

TABLE 12

NUMBERS OF LAMBS PRODUCED BY DAUGHTERS IN RELATION TO NUMBERS PRODUCED BY THEIR DAMS

Average number of lambs by dams	Average number of lambs by daughters
1.0	1.3
1.1 to 1.3	1.36
1.4 to 1.6	1.43
1.7 to 1.9	1.59
2.0 or more	1.72

The same investigator reported data for an English Wensleydale flock; and, on the basis of these studies, he stated that regardless of the fertility of dams, daughters are likely to be equally fertile. He believes that the number of lambs produced is fortuitous and that twin-producing ewes will therefore not have daugh-

[1] Jour. Agr. Res. Vol. 4. No. 6. 1915.

[2] Quoted from Jour. Gen. Vol. 33. No. 1.

ters that will produce more twins than will daughters of single-producing ewes.

There is, however, some evidence to show that it is not impossible to alter the genetic make-up of a flock with respect to the tendency to produce twins. This would, however, take several generations of sheep to accomplish. An experiment[1] was conducted to determine if the tendency of purebred Shropshires to produce twins could be increased in one group of ewes and decreased in another. If any ewe in either group failed to perform in accordance with the purpose of the group, the ewe was culled. The six lamb crops produced showed the two groups of ewes differed consistently in their lambing performance, and it is apparent that a flock may be kept on a high level of lamb production by culling ewes that tend to produce singles. The data in support of this statement are given in Table 13.

TABLE 13

LAMBING RECORD AND PERCENTAGE IN TWO GROUPS OF SHROPSHIRES

Year	No. of ewes	Group	No. of lambs dropped	Lambing percentages	
				Annual	Lifetime
1934	20	Single	25	125	127
	18	Twin	28	156	157
1935	19	Single	25	132	122
	20	Twin	26	130	158
1936	24	Single	23	96	112
	24	Twin	32	133	142
1937	21	Single	30	143	123
	20	Twin	36	180	153
1938	25	Single	34	136	121
	22	Twin	39	177	170
1939	25	Single	35	140	128
	25	Twin	39	156	164

If twinning is inherited, this should be evident from the lambing performance of the ewes produced in the two groups. The data reported by the investigators show some evidence of such, but there is much variation.

[1] Am. Soc. An. Prod. Proc. 1940.

TABLE 14

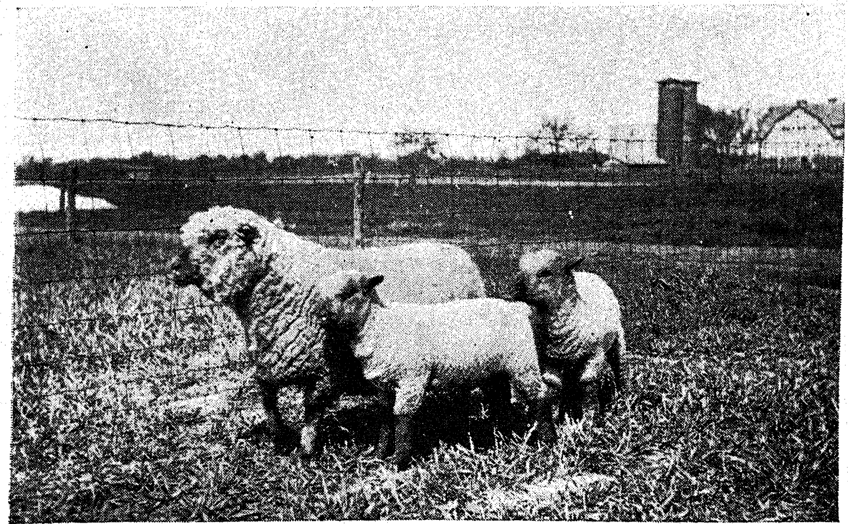
First Year Lambing Record of Ewes Produced in Two Groups

Year	No. of ewes	Group	No. of lambs dropped	Lambing percentage	Difference in per cent
1936	5	Single	5	100	33
	6	Twin	8	133	
1937	8	Single	9	113	65
	9	Twin	16	178	
1938	7	Single	8	114	24
	8	Twin	11	138	
1939	12	Single	16	133	12
	11	Twin	16	145	
1940	8	Single	10	125	−5
	10	Twin	12	120	

It seems the lamb-producing abilities of sheep can be increased if attention is directed toward that end. The continuous selection of twin parentage, both ewes and rams, resulted in a flock of Hampshires so selected producing 200 lambs per 100 ewes. The work of Alexander Graham Bell, in which he endeavored to increase fecundity, apparently met with considerable success, although he based his selections largely on the presence of more than the usual two functional teats.

Flocks under range conditions are not always maintained so that twins are desirable, but some operators who have the needed equipment have found the weight of lamb sold per ewe greatly increased by raising as many twins as possible. With greater attention to feed supplies and pasturage, we may expect more rangemen to find twins advantageous. That twinning has long been considered important by some producers is illustrated by an old adage from England: "Ewes yearly by twinning rich masters do make; the lambs of such twinners for breeders go take."

Growth of twin and single lambs. There is objection on the part of some purebred flock owners to twin lambs because the twins are not as large at birth, and they do not grow as fast as singles. Even though this is true, the twin-producing ewe will have to her credit during the year a much higher production of pounds of lamb than the ewe raising only a single lamb. It is probable that many



Courtesy University of Illinois

Successful twin lamb production is dependent upon milking abilities and upon good nutrition.

farmers are more forward-looking in usually desiring twins than are some breeders of purebreds who dislike them.

Data[1] on the weights of 93 singles and 78 pairs of twins are given in the following table.

TABLE 15

PERCENTAGE DIFFERENCE IN WEIGHTS OF TWIN AND SINGLE LAMBS AT THE SAME AGE

	Percentage difference in weights			
	Birth	84 days	120 days	180 days
Single larger than one twin.	24.0	25.6	20.7	13.2
Pair of twins larger than single.	61.3	59.2	65.9	76.6

Often twins are not the same size at birth, and, while one of a pair is usually smaller than a single lamb of the same parentage, they have apparently a similar capacity for growth. Feed is a limiting factor in the growth of twins; this is shown by the fact that if one twin dies, the other, having a feed (milk) supply corresponding

[1] N. H. Tech. Bul. 14.

in amount to that of a single, will by the end of a six-months period weigh almost as much as the single-born lambs. Since feed is the limiting factor in growth and since milk is the most essential feed in the life of the young lamb, it is essential that attention be given to the milk supply of ewes. There are great differences here, and poor-milking ewes are far from satisfactory for raising twins. Later, other feeds supplement milk, but they cannot satisfactorily take its place early in the lamb's life. In flocks that are not too large, it would be a wise policy to cull those ewes that have lambs weighing less than a minimum set weight at weaning time, just as good dairymen cull cows that do not yield a minimum amount of milk.

Lambs make about 75 per cent of their mature weight by the time they are a year old. This first year's growth is very rapid, especially during the first few months. About 50 per cent of the year's growth is made during the first three months; 25 per cent in the second three months; and 25 per cent in the last six months.

Milk yield. The matter of milk yield in sheep has received scant study, but some studies that have been made indicate that the quality of milk with respect to its fat content varies widely among individuals within breeds, and this seems to be more pronounced than variations between breeds. There is also a great variation in the milk of an individual at different periods during lactation and very probably during different lactation periods. Data indicate ewes' milk to have a considerably higher average fat content than cows' milk. Ritzman [1] showed that 158 samples from a great variety of ewes ranged from 2.4 to 12.1 per cent in fat content and averaged 6.0 per cent. But observations of the growth of lambs support the statement that the amount of milk yielded by the ewes is of more consequence than its quality if this is not too far from average. The increase in weights of lambs is closely proportional to yield and consumption of milk, and these increases may vary as much as 75 per cent between lambs receiving copious amounts and those receiving very small quantities. The feeding and management of the ewes will have a great bearing on the quantity of milk they yield, but good feeding and management will not result in a high yield from an ewe having no inherent capacity for high production.

Selecting ewe lambs on production. Not all operators add ewe lambs to their flocks. There are areas where the purchase of replacements is followed regularly, often because lambs can be

[1] N. H. Tech. Bul. 14.

sold for as much when several months old as yearling or older ewes cost. When keeping lambs from his own flock, the grower has an opportunity to take advantage of several important factors. Whether he wishes to increase the size of his flock or not, he should replace ewes that do not breed regularly, those that lamb later than the main group (if he wishes an early-lambing flock), and also those ewes that are no longer vigorous and thrifty. Too, he will be wise to replace those ewes that prove to be poor lamb raisers whatever the reason.

In selecting ewe lambs, it is well to choose those that are of approved type and early maturing. This is very likely to aid in developing a flock that will produce early-maturing lambs regularly. Because lambs that grow rapidly into a marketable product are often most profitable, this is a matter of some moment. Wool quality and quantity should not be overlooked.

The ewe lambs should be from ewes that are heavy milk producers, and the breeder should know which ewes in his flock are the best milkers. He is certain to accomplish something along this line if he selects the early-maturing ewe lambs, for such have been well fed on a liberal supply of milk from their dams.

Ewe lambs that are retained should preferably be from the first of the lamb crop rather than from the later lambs, especially if it is desired to build up a flock having strong tendencies to breed early. Often, late lambs do not develop as well as the earlier ones, and they are not sufficiently well grown ever to make it advisable to breed them to lamb at one year of age. There is an observed tendency for lambs of the same age to breed about the same time and thus contribute to lamb crops uniform in age.

Records. It is important to have a system of records for the flock so that one may know the good producing ewes, especially if retaining ewe lambs; and although the inheritance of prolificacy has not been thoroughly established, there are other traits that are undoubtedly transmitted, and to know them is important if for no other reason than for culling. Only ewes that produce lamb and wool in excess of the cost of their keep are producers of profit.

The gross income of a ewe may be estimated on the basis of prevailing prices if one knows the amounts of her products. The income from one ewe may be from a 9-pound fleece and an 85-pound lamb; that of another may be from an equal weight of wool and from twins that weigh 150 pounds. These are matters that the

intelligent operator should know about the individuals in his flock. Many base the value of an ewe upon the prettiness of her lamb. A much better basis is both the quality and amount of her products.

Records need not be elaborate. The essential data may be obtained on two or three occasions during the year. The records obtained on some other classes of animals are much more complicated, and many are obtained daily. Any record for the flock need show only the number of the ewe (metal numbered ear tags are suitable for this, although they sometimes are torn from the ears), her wool production, which is readily obtained at shearing time, the date of birth and number of lambs, and number and weight of lambs at weaning time. For small flocks the lambs may be ear-notched at birth, and those to be retained may have metal tags inserted at weaning time or later. Not all the lambs will be the same age at weaning, but allowances may be made for small differences in weight due to differences in ages and also for comparing singles and twins with respect to weights.

That such records may be of much value to the operator is illustrated by the differences in the production of various flocks shown in the data in Table 16.

TABLE 16

LAMB PRODUCTION IN THIRTEEN FLOCKS[1]

No. of ewes	No. of lambs born	Lambing percentage	Per cent raised	Average weight	Pounds per ewe
67	117	180.6	174	91.6	159.8
79	118	149.0	—	54.3	81.1
33	50	151.0	—	73.3	111.0
27	38	141.0	—	68.0	95.7
168	273	162.0	—	74.4	121.0
30	50	166.0	—	—	122.3
111	153	140.0	—	—	114.0
34	53	156.0	150	94.5	145.9
39	55	141.0	136	69.2	95.2
205	352	171.7	142	69.7	137.7
31	62	200.0	92 [a]	90.0	165.6
29	41	141.4	100 [a]	80.5	116.9
20	20	100.0	85 [a]	95	80.7

[a] Per cent of those dropped. Other figures in this column refer to lambs as a percentage of ewes.

[1] Based on reports of Michigan and Minnesota Lamb Production Contests.

CHAPTER 28

The Nutrition of Sheep

All are familiar with the fact that animals live upon the feeds that are taken into their bodies. After the feeds are ingested, they are subjected to the various processes of digestion by which portions become available for the great variety of functions of the body. The undigested residues and waste products formed within the body are excreted. The excreta of animals, often more or less mixed with materials used for bedding, constitute the animal manures which are one of the great by-products of the livestock industry and which, when properly used, serve to return to the soil a large percentage of the materials originally contained in the feeds.

Since the well-being of sheep depends upon feeding and management, the feeds provided for them must contain the nutrients which they need. The practical feeding of sheep is often a relatively simple matter, but the physiological processes of the body are very complicated. It is the province of the science of nutrition to consider the sources of nutrients, the amounts required, their utilization, and similar matters. A thorough understanding of the nutrition of sheep requires a knowledge of many of the facts regarding soils and plants as well as a complete knowledge of animal physiology, for there are important relationships between these matters. Merely to know that sheep eat grass does not constitute any knowledge of their nutrition.

Essential nutrients. The nutrients usually recognized as essential are generally classified according to chemical, physical, and biological properties into six groups. These are carbohydrates, fats, proteins, minerals, vitamins, and water.

Water. Of these nutritive materials, water is the one with which we are most familiar. It performs several very important functions in the body, as it aids in holding other nutrients in solution or suspension and hence helps in the digestion, utilization, and elimination of them or their products. It is responsible in part for

the shape of the body and is a vital item in the control of body temperature. Water constitutes over 50 per cent of the body composition of a lamb. An abundant supply of water is essential to the thrift of sheep. There is a widespread notion that sheep can do well without water, but careful sheepmen always keep a supply for them or drive them to a good source. When grazing succulent forage in cool weather, the amount drunk will be small. Since sheep sweat to only a very slight degree compared with some other animals, the principal means of elimination is through the kidneys and by respiration. Sheep will drink from one to six quarts of water daily.

Carbohydrates. Carbohydrates include a very large group of substances that vary much in appearance. Those carbohydrates with which we are most familiar are sugar, starch, and cellulose or the fibrous or woody parts of plants. They are characterized by the fact that in composition they contain hydrogen and oxygen in the same proportion as these exist in water; they are free of nitrogen and therefore are often referred to as the nitrogen-free extract of feeds. Grains are high in nitrogen-free extract while roughages are much lower, and that in roughages is usually much less digestible, for in the latter much of the material is in the form of fiber. Pentosans are similar in some respects to starches and sugars but are found mainly in the fibrous portion of plants. The value of these materials to sheep is of two distinct kinds: the fibrous portion helps to form bulk, a matter of extreme importance in the diet of all herbivorous animals, of which sheep are a part; the sugars, starches, et cetera are very important sources of energy. A surplus taken into the body may be transformed into fat and stored as a reserve supply for later use in the production of heat and energy. If the supply of carbohydrates is inadequate, it is possible for sheep and other animals to make up for the deficiency by using the protein and fat contained in the feed. Carbohydrates are needed in abundance in the rations of fattening sheep. Apparently, these materials cannot be used for body functions other than for the deposition of fat and the production of heat and energy. One of the most common practical consequences of a lack of carbohydrates in the ration is an increase in expense, as they are among the cheapest nutrients.

Fat. Fat or similar materials are found to some extent in almost all feeds. Seeds of certain plants are high in oils or fats, while the stems and leaves contain very little. From the standpoint of the

nutrition of sheep, it is likely that some fat in the feed is desirable, although it seems unlikely that these animals suffer from a deficiency of dietary fat. The fat may be used for energy, or it may be converted into body fat and stored with fat formed from other nutrients. Body fat of sheep has a very high melting point, and it is apparently not affected in any significant way by the kind or amount of fat in the usual feeds.

Proteins. Proteins are very complex compounds which serve considerably different uses from those served by the other nutrients. For sheep the proteins are almost exclusively of plant origin. The leaves and seeds of plants are rich sources of proteins. The protein content of plants differs greatly, however, both with respect to quantity and quality. Differences in quality seem to be closely allied to the various amino acids of which the protein is composed. Some amino acids may be synthesized in the rumen. All proteins contain nitrogen, carbon, hydrogen, and oxygen, and some also contain phosphorus, iron, and sulphur.

The percentage of protein contained by the dry matter of feeds used for sheep varies from about 5 to 20 in the case of roughages up to around 45 for some of the concentrates. Among the best sources of proteins are the leguminous plants which form such an important element in the pasture and agricultural industry. These plants are able to make use of the nitrogen of the atmosphere, which constitutes such an important element of soil fertility.

Sheep require liberal amounts of proteins for growth, for the replacement of body tissues and fluids, for reproduction, and for the growth of wool. Sheep can subsist on feeds partially deficient in protein, but they cannot give maximum production. The protein requirements of pregnant ewes is very high, much higher than in beef cattle, for sheep reproduce in a shorter time and often have two or more lambs, which represent a large percentage of the body weight of the ewes. It has been shown that the daily protein requirement for wool growth alone is from 0.09 to 0.15 pound per 1,000 pounds of live weight. Since the wool fiber is chiefly protein, and the demands for protein for other purposes is high, the significance of a diet adequately supplied with this nutrient is evident. In general, sheep are unable to produce protein from other materials. However, it has been established that a nonprotein nitrogen compound, urea, may serve as a source of protein for ruminants because of the utilization of the urea nitrogen by some of the bacteria

and protozoa in the paunch of such animals. The bacterial and protozoan proteins are then utilized by the sheep.

The ration of sheep should contain at least 9 or 10 per cent protein, preferably 13 to 14 per cent, and it has been observed in many cases that a much higher intake increases the rate at which lambs grow and fatten. If the protein is insufficient, the most obvious symptom is a decline in the appetite for feed and a slowing up or a cessation of growth, together with a very poor development of the muscles in growing lambs. In mature ewes there is a lack of thrift and poor wool growth; there may also be some impairment of reproductive functions shown in the dropping of weak lambs and the scant milk flow for support of the offspring. Experiments have shown that sheep utilize the protein of the ration better if it is close to the minimum needs, but there is no apparent harm to any of the body organs if it is fed to a much greater extent than needed to meet requirements. Although it may not be so efficiently utilized, the resulting production will be satisfactory. Perhaps the lowered efficiency in utilization when protein is fed in large quantities is due to the lack of sufficient nonnitrogenous nutrients to enable sheep to use the protein with maximum efficiency. This may be an explanation of the usually satisfactory results secured in lamb fattening with a ration of alfalfa and corn. These two feeds often produce as good results as can be obtained with more complicated diets. It is possible that some of the beneficial effects of high protein feeds are due to other essential nutrients, such as vitamins and minerals often found in such feeds.

Digestible nutrients. Not all of a given nutrient in a feed is digestible. The foregoing nutrients, carbohydrates, fats, and proteins, to the extent to which they are digestible, are frequently referred to as total digestible nutrients. This is often expressed in an abbreviated form as T.D.N. In determining the total digestible nutrients in a feed, the carbohydrates and protein are considered as having the same value, but the amount of fat is multiplied by 2.25 before it is added to the amounts of the other two nutrients. This is done because fat yields approximately 2.25 times as much energy as either of the others. The T.D.N. represent approximately the energy of the feed or ration. The other expression used along with the T.D.N. is the digestible crude protein. Rations are usually considered adequate in comparison with standard amounts of these constituents. The standard for ewes weighing 150 pounds and nurs-

ing a lamb is given by Morrison in *Feeds and Feeding* as 0.32 to 0.35 pound of digestible protein and 2.8 to 3.2 pounds of total digestible nutrients daily.

Table 17 on page 248 shows the recommended allowances for sheep of various classes. The table is based on, and the data taken from, a similar compilation made by a committee of workers in the fields of sheep husbandry and nutrition.[1]

Use of nutrients. Complete information is not available regarding the proportions of each nutrient that is used by sheep for the various activities associated with life processes, but it is from these nutrients that the requirements for maintenance and production are met. Some of the essential body processes concerned wholly or partially with maintenance are: (1) heat production and control of body temperature; (2) the ingestion, mastication, digestion, and assimilation of feed and its passage through the alimentary tract; (3) the circulation of the blood; (4) respiration; (5) the elaboration of glandular secretions; (6) muscular activity involved in connection with life, even though nonproductive; (7) nervous impulses and responses; and (8) the elimination of waste materials.

Sheep, like other animals, require a considerable amount of feed for the purposes listed. In addition they need nutrients for production, which involves growth or the formation and enlargement of tissues, reproduction, the secretion of milk, and the growth of wool. It is important to note that sheep are always producing as well as being maintained, since the growth of wool fibers is a process which continues throughout the life of the animals. Nevertheless, even when being fed for production, as much as one-half of the feed which they consume is needed simply for maintenance.

The maintenance requirements are not the same under all conditions. The amount of nutrients needed to maintain the temperature of the body would be greater under some conditions than under others. The principal means by which heat escapes from the body are radiation from the body surface and through respiration, in which heat is lost through the moisture in the expired air. Such practices as shearing would therefore have some bearing on the control of body temperature and the maintenance requirement. Another illustration of variation in maintenance needs can be shown by a comparison of a sheep in ordinary condition and when

[1] Recommended Nutrient Allowances for Domestic Animals. No. 5. Nat'l. Res. Coun. 1945.

TABLE 17

DAILY NUTRIENT ALLOWANCES FOR SHEEP

Approximate live weight	Total feed (air dry)	Digestible protein	Total digestible nutrients
lbs.	*lbs.*	*lbs.*	*lbs.*
		Bred ewes	
		For 3 to 4 months of gestation	
100	3.2–3.5	.16–.19	1.6–2.0
110	3.4–3.7	.17–.20	1.8–2.2
120	3.6–4.0	.18–.21	1.9–2.3
130	3.8–4.2	.19–.22	2.0–2.4
		For last 4 to 8 weeks of gestation	
110	4.0–4.4	.21–.24	2.0–2.4
120	4.1–4.5	.22–.25	2.1–2.5
130	4.2–4.6	.23–.26	2.2–2.6
140	4.3–4.7	.24–.27	2.3–2.7
150	4.4–4.8	.25–.28	2.4–2.8
		Ewes in lactation	
100	4.3–4.7	.24–.27	2.3–2.7
110	4.4–4.8	.25–.28	2.4–2.8
120	4.5–4.9	.26–.29	2.5–2.9
130	4.5–4.9	.27–.30	2.6–3.0
140	4.6–5.0	.28–.31	2.7–3.1
150	4.7–5.1	.29–.32	2.8–3.2
		Lambs	
		Growing	
70	2.4–2.8	.17–.21	1.4–1.8
90	2.6–3.0	.18–.22	1.6–2.0
110	2.8–3.2	.20–.23	1.8–2.2
130	3.0–3.4	.21–.24	1.9–2.3
		Fattening	
50	2.2–2.6	.17–.21	1.1–1.6
60	2.4–2.8	.18–.22	1.4–1.6
70	2.6–3.0	.20–.24	1.6–1.9
80	2.7–3.2	.21–.25	1.8–2.1
90	2.8–3.4	.22–.26	1.9–2.2

fat. The needs for maintenance of the fat sheep are greater than if in lower condition because the requirement has a relationship to the body surface and to body weight, both of which are greater when the animal is fat.

The nutrient requirements of sheep that are producing are much higher than of those that are merely maintained. Not only are far greater amounts needed, but there are striking differences in the relative amounts of the various kinds of nutrients needed for these two purposes.

Minerals. Sheep have certain definite mineral needs. Without these minerals proper nutrition is not accomplished, but feeding them to excess is in no wise supported by investigations of the problem. Eleven mineral elements have been found essential for sheep and other herbivorous animals. These are calcium, phosphorus, sodium, potassium, chlorine, magnesium, iron, iodine, sulphur, copper, and cobalt. In addition to these there has been some evidence to indicate that manganese and zinc are necessary for various body functions.

Minerals fulfill three main functions. First, as parts of the bones and teeth, they give form, rigidity, and strength to the skeleton. Second, they regulate the neutrality of the body fluids, which is a necessary condition for the proper functioning of the body cells. Third, they form essential parts of certain organic compounds which occur in the muscles, blood, and various secretions.

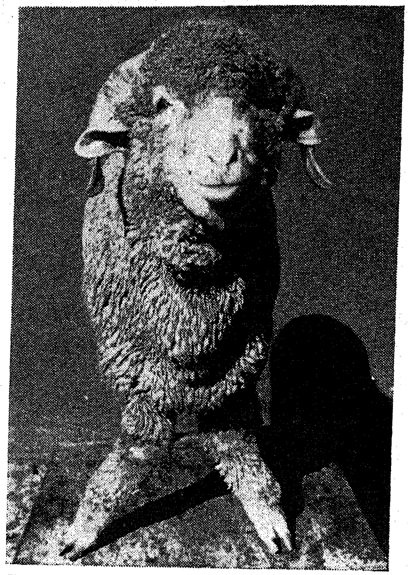
Salt. Salt is a combination of sodium and chlorine, two of the essential minerals. These minerals perform an important work in maintaining the osmotic pressure in the cells of the body and thus aid in the transfer of nutrients to the cells and in the removal of waste materials from them. Both of these minerals are also found in the blood. Chlorine is required for the production of the hydrochloric acid of the gastric juice, which is one of the digestive juices of the stomach. Sheep have a very low stomach acidity, but they have a great need for salt and become so hungry for it if deprived of it for a considerable period that they may overeat, and death may result. The daily salt consumption ranges from one-quarter to three-quarters ounce daily per head, depending upon the size of the animal and upon the character of the feed. Rangemen usually figure the requirement as a pound per month for each sheep. There are some coastal areas and some alkali regions where the salt content of the herbage and soil is so high that sheep require no salt

in addition. However, in all other areas salt in some form should be available to them at all times. This is a better practice than giving salt at weekly intervals. Although there is often much discussion regarding the relative merits of salt in various forms, there are no fundamental differences except some forms can be more readily eaten than others. There is no doubt that a lack of salt is a far more common cause of mineral deficiency among sheep flocks than is the lack of any other mineral. This arises because of the failure to provide it regularly and in ample quantities and because it is excreted daily, chiefly in the urine. Some may be lost in perspiration, but this is not as important an avenue of loss as in the case of other animals. A deficiency of salt is shown first by a great craving for it. A decline in thrift follows slowly, for under such conditions the excretion of salt almost ceases, and the small supply is retained as long as possible. There is listlessness, a loss of appetite, and a decline in weight. These symptoms are rapidly overcome with the restoration of salt to the diet.

Calcium and phosphorus. These two minerals are closely associated in nutrition. They are the most important mineral constituents of the body so far as quantity is concerned. Together they make up about 70 to 75 per cent of the total mineral matter of the animal body. About 99 per cent of the calcium and 80 per cent of the phosphorus is found in the bones and the teeth. They are very important in milk as they represent more than half of its mineral content. Hence, there is a strong need for calcium and phosphorus in the rations of pregnant ewes, of ewes giving milk, and of growing lambs. However, this must not be taken to mean that mature animals that are not producing do not need these minerals, for there are daily losses from the body which must be replaced.

Under many conditions the supply of these minerals is entirely adequate in the pastures and roughages used by sheep. But there are many regions where the supply of calcium and phosphorus in soils has been depleted by long crop production without replenishment. Under such conditions there may be lowered efficiency, reduced production, and cases of serious injury or even death. The requirement of calcium is greater than that of phosphorus, but sheep are more likely to experience a lack of phosphorus than of calcium. This is because roughages make up a large part of the ration of sheep, and roughages contain more calcium than phosphorus. It is only through the use of roughages of very

low grade grown on poor soils that a serious deficiency of calcium is apt to result. An insufficient amount of calcium results in weakened bones and lameness. Rickets or "bent leg," as the condition is usually known in sheep, is due to a lack of calcium being deposited in ample amounts. The difficulty is more likely to be due to an accompanying lack of vitamin D necessary for the deposition of calcium than to a critical lack of the mineral alone.



Courtesy University of Illinois

Rickets or "bent leg" is due to faulty mineral and vitamin nutrition.

A lack of phosphorus is shown by symptoms similar in some respects to those due to calcium deficiency. There is stiffness and soreness of the joints, listlessness, lack of appetite or a depraved appetite which is manifested by attempts to eat bones or chew wood. Other conditions are reduced growth, loss of flesh, failure to breed regularly, and poor milk production. Some instances of the lack of milk at lambing may be due to a lack of phosphorus. Since phosphorus is a part of some of the proteins, it is unlikely that a deficiency will develop if protein-rich feeds are used.

Feeding extra amounts of calcium and phosphorus will result in bones of greater strength and of denser structure, but there is very little effect on the outside diameter. The assimilation of calcium and phosphorus seems to depend to some extent upon the relation between the two. It appears that a ratio of 2 to 1 is satisfactory.

Iodine. This is one of the minerals that may be deficient in rations in certain sections of the country. About half of the iodine of the body is found in the thyroid glands of the neck. This organ is very important in relation to health, growth and general development, and reproduction. Deficiency symptoms are revealed by lambs having very little or no wool at birth and by slight to extreme

enlargement of the thyroid gland. This condition is described by practical sheepmen as "big neck" or goiter. The death rate of such lambs is high. The condition is easily prevented through the use of an iodine supplement, such as iodized salt.

Magnesium. Magnesium is present in the bones, fluids, and tissues of the body. It is unlikely that sheep experience any lack of this mineral, although a few cases of "grass tetany" have been ascribed to it.

Potassium. This occurs largely in muscles. Apparently no deficiencies have been found, although some soils do not have an ample supply for large plant production.

Sulphur. Sulphur is a constituent of some proteins and is found to some extent in wool. There is some evidence to the effect that it is not available to animals except when in the organic form found in feeds. When fed in the form of ordinary flowers of sulphur, most of it is eliminated without having been absorbed. No deficiencies have been found in this country.

Iron, copper, and cobalt. These minerals seem to be associated in some of the body functions. Iron is an important part of the blood. Copper and cobalt are related in some way to the formation of blood. A lack of any one or more of these minerals results in a decline in the red blood cells and in the hemoglobin and the development of a nutritional anemia. The condition is referred to as "salt sick," "bush sickness," "pining," and by many other terms. It is not common in this country but has been found in restricted areas and in various parts of the British Isles and in Australia in particular. Iron deficiencies probably do not occur under natural conditions except in very limited areas. If there is a lack of cobalt or copper, it may be overcome by using such materials as cobalt chloride and copper sulphate. Spraying four ounces of the cobalt chloride on a ton of salt has been found ample. If copper sulphate is mixed with salt, it should probably not be made richer than one pound to a hundred pounds of salt, as a large continuous intake is harmful. These elements are needed in extremely small quantities to maintain health.

Manganese and zinc. If these are needed by sheep, it seems highly probable they will be supplied in ample quantities in pastures or other feeds.

Mineral supplements. There are circumstances when the use of mineral supplements may be advisable. It is often assumed that

only 35 to 50 per cent of the minerals of the ration are used by the animals, and two or three times the theoretical requirement is therefore recommended. The producer can afford to be liberal, as the cost is usually rather low; but minerals are of no value except to correct deficiencies, since they do not stimulate production above a normal level, and their value depends solely upon the extent to which the lack is made good. The practice of including in commercial mixtures many more components than are necessary only increases the costs without improving the effectiveness. Commercial mixtures may be eaten in large amounts because of the inclusion of certain condiments, but the amount eaten is not necessarily a criterion of need or value. The real test is whether one secures better health, more rapid growth, increased efficiency, and greater production of the sheep.

Mineral poisoning. Some minerals are poisonous to sheep. In some localities in the western range states selenium occurs to such an extent in some feeds that a disease known as "alkali disease" is caused by it. Affected animals may lose their coats, become lame, lose their appetites, and finally die. However, if affected animals are fed on feeds free of selenium, recovery may be expected.

Flourine. Fluorine is apparently not contained in plants to a harmful extent; but, if minerals, such as raw rock phosphate, that contain significant amounts of fluorine are fed, the animals may show the effects by a discoloration and softening of the teeth and bones.

Other minerals such as the lead of paints or of spray materials are poisonous, and suitable precautions should be taken to keep animals away from them to avoid losses.

Vitamins. A general knowledge of the vitamins and their importance in nutrition, including the conditions under which deficiencies may occur and how to prevent them by the use of suitable feeds, is necessary for continued success in sheep feeding. Fortunately, the development of deficiencies to the extent where they cause serious losses in sheep are apparently rare. At the present time it has not been established whether all of the known vitamins are essential in the diet of sheep. The two which seem to have most significance in sheep feeding are vitamins A and D.

Vitamin A. This vitamin is synthesized by animals from the carotene of plants. Carotene is abundant in the green parts of plants and is also plentiful in the yellow coloring matter of corn.

carrots, sweet potatoes, and yellow mangels. Its discovery explains why sheepmen had long insisted that there were certain things of great nutritive value in such things as carrots that had not been revealed by the usual analysis pertaining only to nitrogen-free extract, protein, minerals, and dry matter. Vitamin A promotes growth and aids in protection against respiratory infections and impaired vision. A deficiency of this vitamin in sheep is characterized by night blindness, sore eyes, poor appetite, poor condition, and weakness. Affected ewes may abort, or their lambs may be very weak and die soon after birth. Although the carotene of feeds may decrease rapidly during curing and storage, high grade legume hay of good green color, good silage, and roots, such as carrots, are fair to good sources of vitamin A. Green pastures, however, are the best natural sources for sheep. It is not unreasonable to suggest that some of the difficulties that develop during the late winter months, especially after periods of summer drought, may be associated with a deficiency of this vitamin. It is stored in the liver of sheep, but there may be cases where storage is not ample to meet all of the various needs of breeding ewes and their lambs.

Vitamin B. Sheep should seldom suffer from any lack of vitamin B, for it has been shown that they have the ability to synthesize practically all of the known vitamins in the B-complex in the rumen. It is generally thought that all of the vitamins thus formed become available to the sheep as the feed is later digested. The B vitamins furnish a stimulation to the appetite, protect against nervous disorders, and are essential for reproduction and lactation. There may be cases of deficiencies in newborn lambs, but none has been thoroughly demonstrated, and it is unlikely that they occur in older lambs and sheep, since, in addition to the synthesis in the rumen, most feeds have ample for usual conditions. Yeast is very high in vitamin B.

Vitamin C. It is probable that sheep require ascorbic acid or vitamin C, but, since it is present in most pasture grasses and may also be formed by these animals, there is slight possibility of any inadequacy.

Vitamin D. For sheep the only important sources of vitamin D in feeds are in field-cured hays, as growing plants and grains have very little or none of the material. When sheep are exposed to sunshine, vitamin D is formed in the body by the action of the ultraviolet rays. Hence, any deficiency is most likely to be evident late

in the winter after periods of cloudiness and when the sunshine is not so effective. Vitamin D is an essential for the metabolism of calcium and phosphorus and for the formation of bone. Without adequate vitamin D young animals develop rickets or a "bent-leg" condition. Vitamin D cannot make up for a lack of calcium and phosphorus, but these minerals cannot be effectively used in the absence of this vitamin. Some spasms and sudden death in winter lambs when some weeks of age have been assumed to be associated with inadequate vitamin D.

Vitamin E. In some animals normal reproduction is impossible without vitamin E, but there are few reports regarding its need by sheep. Since most feeds, especially legume hays and green pastures, are good sources of the vitamin, it is seldom that the natural supply will be insufficient. The use of wheat germ oil which is high in vitamin E has not been conclusively demonstrated as of any benefit to reproduction in sheep.

There is little information regarding any other vitamins for sheep.

Balanced nutrition. The first principle in practicing a good or well-balanced nutritional regime for sheep is to feed them liberally on palatable, nutritious feeds. Since sheep gather such a large portion of their feed by grazing, the intake of feeds is usually limited by the palatability of the various plants and the capacity for feed. Under farm conditions attention to the fertility needs of the soil for the production of high-yielding, nutritious pastures and roughages and careful harvesting and storing of the latter are therefore important considerations. For range sheep, grazing management to encourage good forage growth and the supplying of such supplementary feeds as needed to provide adequate amounts of various nutrients are basic problems. Further discussion of these matters is found in the succeeding chapter.

Digestion. All of the changes which occur to the food after it is eaten and before any of its parts are absorbed from the digestive tract and used by the body are known as digestion. Sheep have a complicated digestive tract. Chewing or mastication either before the food is swallowed or after it has been first swallowed and temporarily stored in the paunch or rumen and then regurgitated is a mechanical phase of digestion. Another mechanical phase occurs as the food is further mixed and probably broken apart to some extent by the motions of the stomach. Later phases are chemical

and are produced largely by enzymes contained in the secretions of various parts of the digestive tract or of glands whose secretions enter it. The first of the secretions to come in contact with the feed is the saliva. The saliva of sheep very probably does not contain much of the enzyme, ptyalin, whose chief purpose is the changing of starch into sugar. In the first three compartments of the stomach there is a great deal of bacterial action which serves to digest some parts of the feed, especially some of the cellulose pentosans and other carbohydrates. From these, organic acids and perhaps simple soluble sugars are formed. This bacterial action is one of the reasons ruminants, such as sheep, are able to make such good use of roughages. Along with this action there is a considerable production of heat which may serve to keep the body warm, or it may be a loss if the body heat is already normal. This process also results in the production of considerable amounts of gas. When gas formation is very rapid and there is an absence of belching, bloating occurs. If sugar is absorbed in excess of immediate needs, it is stored in the liver in the form of glycogen, to be later withdrawn and used. The blood normally contains about 0.1 per cent of glucose.

In the true stomach, or abomasum, the proteins are attacked by the enzymes or digesting agents of the gastric juice. Pepsin is the principal protein digesting agent. Pepsin does not complete the digestion of protein, however, as the resulting products of its action, together with any protein which has escaped contact with pepsin, are later acted upon in the intestines by trypsin of the pancreatic juice and erepsin, an enzyme of the intestinal juice. Protein digestion results in the production of amino acids which are readily absorbed and pass into the blood, by which they are carried, to all parts of the body for growth and the repair of tissues.

The fat of rations fed to sheep is acted upon first by the bile secreted by the liver. This action occurs in the small intestine. The fat is emulsified or broken up into small particles, after which the lipase of the pancreatic fluid splits it into fatty acids and glycerin. Apparently, after the products of fat digestion are absorbed, fat is again formed.

Water requires no action to be used by the body. Minerals are acted upon by the hydrochloric acid in the gastric juice, although those minerals, such as phosphorus and sulphur, that are parts of proteins are digested in the processes affecting proteins. Vitamin digestion and absorption are not completely understood,

although since some of them are formed by the sheep it is possible that these at least are absorbed directly.

Feces or manure. Feces or manure consists mainly of the undigested residues of the feed, but there are also other materials such as residues of the digestive juices, worn-out cells, especially from the lining of the digestive tract, various excretory products, and bacteria. Mineral matter is contained in the feces, but appreciable amounts of some minerals are also found in the urine. Most of the nitrogenous waste products of the body are excreted through the kidneys. Although these are the main avenues for the disposal of body wastes, there is some escape through the skin.

Because the manure of sheep, as well as that of other farm animals, contains important amounts of materials which were previously removed from the soil by the plants, care should be taken to conserve its fertilizing value and to return these substances to the soil. It is estimated on the basis of tests that 80 per cent of the fertilizing value of the feed is recoverable in the urine and feces. It is evident that the composition of these materials is largely dependent upon the character of the ration which is provided. However, the value of manure as a fertilizer does not depend wholly upon the minerals and nitrogen it contains, for the organic matter and very probably even some of the bacteria and other products have beneficial effects on the soil.

Manure produced by sheep is usually drier than that of cattle, and partly because of this it has a higher value per ton. This is shown in the following tabulation.

TABLE 18

USUAL COMPOSITION OF SHEEP AND CATTLE MANURE [1]

	Water	Nitrogen	Phosphorus	Potassium	Value per ton
Sheep					$4.88
Per cent	64	1.44	0.22	1.01	
Pounds per ton	—	28.0	4.4	20.2	
Cattle					$2.64
Per cent	78	0.73	0.21	0.46	
Pounds per ton	—	14.6	4.2	9.2	

In saving the fertilizing value of the manure when sheep are fed in barns or sheds, sufficient bedding should be used to absorb the urine, for it contains more than half of the nitrogen excreted.

[1] Ohio Bimonthly Bul. Vol. 12. No. 3. May-June, 1927.

CHAPTER 29

Feeds

Sheep are adapted to the consumption of rather bulky feeds, and most of the common feeds used by them are of plant origin. Very little use is ever made of such feeds as tankage or other animal by-products or milk products. The only time when milk is of much consequence as a feed for sheep is in the case of lambs when they are nursing or in a few cases of lambs being fed as orphans.

Classes of feeds. Concentrates and roughages are the two large group classifications of feeds. Concentrates seldom account for more than 50 per cent of the ration by weight, and such a percentage is generally found only in the case of lambs or sheep that are being fattened. Roughages may make up 100 per cent of the ration. Indeed, this is the percentage in the great majority of the rations for most sheep at most seasons of the year. Many lambs are marketed as fat lambs directly from pastures and ranges, without having been fed any concentrates. The ability of sheep to thrive on good pastures and roughages is thereby strikingly illustrated. But concentrates do have an important place in the feeding of sheep.

Food value. The feeding value of plants and plant products is chiefly dependent upon their chemical composition. Plants similar in composition may not have equal value because of differences in palatability and in digestibility. But the greatest differences are usually associated with differences in composition. Some plants contain materials that are poisonous to sheep.

The composition of plants varies with the species and, in some cases at least, with the variety within a species. In fact, it is not unusual for the differences in chemical composition between two varieties to be greater than the differences between two species. In many instances of this kind in cultivated crops, selection within the species has been an important item in developing the differences.

The fertility of the soil may have an important effect upon the nutrient content of plants and upon the amount of plant growth.

But regardless of fertility, plants vary in composition and in the amounts of nutrients yielded per acre. However, the most fertile soils yield the most nutritious plants, for all of the materials which plants need, except carbon dioxide, are obtained by the plant from the soil. Under certain conditions nitrogen may also be obtained indirectly from the air by leguminous plants, but the nitrogen of others is obtained from the soil. Fertile soils are those which have an abundance of plant constituents in available forms for the plants to use. Materials essential for abundant plant growth are also necessary for the nutrition of sheep, and hence both plants and animals may be looked upon as products of the soil.

Soils and nutrition. It is important to emphasize the relationship which soils bear to nutrition. In no class of animals is the relationship of soils to nutrition and feeding of more importance than with sheep, for it is customary to produce them on the plants of the region, and the amounts of feeds purchased from other areas are usually small. If soils are deficient in plant food materials, the growth of plants is reduced, and the composition of the plants is altered from that developed under conditions of greater abundance of the necessary elements. Plant growth removes materials from the soil, and the replacement of these materials to the soil and their conservation is a continuous problem on farms. The production and sale of animals which live on these plants and their products also remove fertility from soils, although usually at a slower rate than other types of farming. However, it is entirely possible that under conditions where the animal manures are not well handled there is less difference between loss of fertility with grain farming and livestock farming than is commonly supposed.

A realization of the necessity for the return of these various elements to the soil, under the most economical practices, so they may again be used for production is a basic consideration in soil management and in plant and animal husbandry. It is clear that the chemical composition of plants with respect to both their mineral content and organic make-up may be modified by soil fertility and management. It is equally well established that the value of plants as feed for animals varies with their chemical and physical characteristics. These matters are true whether the plants are grazed while in a growing stage or whether used after harvesting. Hence, the solution of some of the nutrition problems of sheep and other animals goes back largely to the soil, where the deficiency

may be corrected through the application of needed plant nutrients. Soil management practices directed toward the maintenance of fertility and the control of erosion therefore have a direct bearing on sheep husbandry.

It is important to note that a scant plant growth may not indicate serious soil deficiency in mineral elements. This may be due entirely to a lack of water or soil moisture. Some of the irrigated and adjacent areas of the West are good illustrations of this fact.

Soil deficiencies. Soil deficiencies most commonly encountered are calcium and phosphorus. There are, however, important considerations with respect to the supply of potassium, iron, magnesium, iodine, cobalt, and other elements that now have localized significance and that may become of greater consequence in animal production.

Calcium. Calcium may be present in sufficient amounts for some plants, but others, such as some of the legumes, may not thrive or even grow. The calcium content of the plants in all cases may be less than if more calcium were present in the soil or if there were a different soil reaction, which the application of limestone or other calcium bearing materials may cause. A reduction in the calcium content of plants may result in an insufficient supply for animals. This may be corrected by the application of calcium to the soil. The Kentucky Station reports Korean lespedeza as having 0.89 per cent calcium and 0.14 per cent phosphorus when grown on deficient soil, but 1.28 per cent calcium and 0.32 per cent phosphorus on soils plentifully supplied with these materials. Lespedeza is capable of growing on relatively poor soils, but its nutritive value may be enhanced by soil treatment.

Phosphorus. Phosphorus is probably more widely deficient in soils than any other mineral needed for abundant plant growth and for the nourishment of sheep. Soils low in phosphorus yield small amounts of plant products, and these products may be low in phosphorus content. It has been shown that lambs when fattening need a ration containing from 0.15 to 0.23 per cent of phosphorus to make reasonably fast gains in weight.[1] The phosphorus content of grass growing on soils deficient in this mineral may be as low as 0.10 per cent while on fertile land the percentage will be 0.30 or more. Legumes, which are among the best plants for sheep, are very sensitive to the supply of soil phosphorus and fail to thrive

[1] Beeson, W. M. et al. Jour. An. Sci., Vol. 3. No. 1. Feb., 1944.

and yield well if it is depleted. Plants growing or grown on soils high in phosphorus are more palatable than if this mineral is lacking. The application of phosphorus-containing materials to soils increases both phosphorus and nitrogen in plants and stimulates their rates of growth, which may partially explain their greater palatability to sheep.

An effect of great consequence which results from the application of needed plant materials to the soil has been demonstrated at the Illinois Station.[1] Lespedeza grown on land well supplied with lime had from 40 to 75 pounds more protein per ton of hay than that grown on adjacent land lacking lime. When phosphate materials were used along with the lime, the protein content of the hay was further increased by 10 to 20 pounds per ton. In addition to larger yields of hay, the hay was of improved feeding value. Thus, attention to soil fertility may be a factor of great moment in the health and vigor of sheep as well as in the amount of product per acre. Because of the relationships of soil fertility to nutrition, the fertilization of soils may be of far more consequence to sheep production than the frequent attempts to "doctor" animal rations.

Nitrogen. The nitrogen content of the soil has a great influence on the yield of forage, and it also influences the protein content of grasses. The application of nitrogen to the soil increases the yield, palatability, and feeding value. In New York, nitrogen fertilization increased the yield of timothy hay 35 per cent and the protein content of the hay from 8.0 to 9.4 per cent when cut in the early to full-bloom stage. Grasses grown with legumes are similarly benefited from the nitrogen-fixing bacteria. In Illinois, bluegrass grown alone had 180 pounds of protein per ton of hay, but when grown with lespedeza the bluegrass had 240 pounds per ton.

Iodine. Of the other deficiencies in soils that may affect the value of feeds for sheep, iodine is of most importance in this country. The areas where this element is known to be deficient are found in Montana, Idaho, Oregon, Washington, Utah, Wyoming, North Dakota, Minnesota, Wisconsin, and Michigan. Some deficiencies have been reported in sections of California, Nevada, Colorado, Nebraska, Iowa, and Texas. There have been occasional cases of deficiencies in Illinois and elsewhere in past years. The use of iodized salt in all such areas will correct a very large percentage if not all of the difficulties. Iodine should not be fed to excess.

[1] Reported by H. J. Snider. Univ. of Ill. 1945.

Trace elements. Feeds are seldom deficient in the so-called trace elements, iron, manganese, cobalt, and copper, needed by sheep. The present likelihood of such deficiencies in the United States is very remote except in parts of Florida where copper and possibly iron seem to be present in insufficient amounts. The indiscriminate use of copper compounds, such as copper sulphate, in feeds or salt, usually in an effort to control parasitism, has resulted in copper poisoning of sheep. In a test at the Illinois Station some sheep which were apparently well fed remained unthrifty and showed a low hemoglobin content of the blood. The administration of minute amounts of cobalt or of a mixture of powdered salts containing iron, copper, magnesium, manganese, and cobalt resulted in such marked improvement that the possibility of a borderline condition with respect to some of these materials should not be overlooked in some areas. Cobalt deficient areas are known in New Zealand, Australia, and in Great Britain. An extremely small amount of a soluble cobalt salt sprinkled on the ground in some such places has shown that sheep raising can be changed from an enterprise of great uncertainty to a profitable one. A cobalt deficient area has been found in Wisconsin.

Plant maturity. Despite the great importance of soils as an influence upon the amount of nutrients plants contain, there are other items that have a bearing on this matter. The composition of a plant varies with the stage of maturity. Immature plants contain much more water and less dry matter than the same plants when mature. On a dry-matter basis, actively growing plants are higher in protein, mineral, and vitamin A and lower in fiber than they are at maturity. The young plants are therefore more digestible, and this is one reason why young pasture plants are more nutritious

TABLE 19

Composition of Barley Plants (dry basis)

Age in days	Ash per cent	Protein per cent
7	13.68	—
21	16.84	38.0
35	14.20	24.1
49	10.12	12.2
63	8.66	9.9
77	7.77	6.1
86	7.49	3.7

than the same plants used as hays. Under pasture conditions, where many of the plants are kept in a vegetative or growing stage by the animals eating the top portions, the plants tend to have a composition approximating that of young plants.

The composition of growing barley was reported in Table 19.[1]

A similar study of sudan grass showed the following composition at various stages of growth: [2]

TABLE 20

COMPOSITION OF SUDAN GRASS AT SUCCESSIVE STAGES OF GROWTH (DRY BASIS)

Stage of maturity	Dry matter	Protein	Fiber	Nitrogen-free extract
	per cent	*per cent*	*per cent*	*per cent*
2 feet or less	15.5	20.2	24.2	45.7
3 to 4 feet	13.9	15.5	26.0	48.7
4 to 6 feet	20.0	8.3	29.8	56.0
Early bloom	22.3	8.1	30.6	56.2
Seed stage	41.3	5.3	33.4	55.4

The Kansas Station reported that the high nutritive value of young plants of winter wheat and rye was due to the large amounts of nutrients contained in the dry matter. These data help explain the quick response of sheep and lambs to such feeds at various seasons.

TABLE 21

FEED CONSTITUENTS OF GROWING WHEAT, RYE, AND BLUESTEM (DRY BASIS) [3]

Forage	Date	Protein	Fiber	Ash	Nitrogen-free extract
		per cent	*per cent*	*per cent*	*per cent*
Kanred wheat	Nov. 4	28.28	13.25	12.34	41.54
	Apr. 26	17.76	21.52	11.44	46.10
Winter rye	Nov. 4	29.97	15.07	12.99	36.16
	Apr. 26	28.00	19.46	13.46	33.72
Little bluestem	May 8	15.80	26.00	8.58	46.94
	June 5	9.11	31.36	8.03	49.91
	June 19	6.43	32.55	7.13	51.48
	Aug. 1	3.84	34.53	6.98	51.85
	Dec. 20	2.29	36.60	8.05	51.80

[1] PHILLIPS, M. and GOSS, M. J. Jour. Agr. Res. 51:301. 1935.
[2] WRIGHT, P. A. and SHAW, R. H. Jour. Agr. Res. 32:321. 1926.
[3] Kansas Agr. Exp. Sta. Bul. 271.

Very probably these and other differences in the composition of plants at different stages explain why sheep prefer short, young forage to more mature plants.

Plant palatability. Practical sheepmen speak of the relative palatability of various feeds. Sheep may eat a plant or feed with apparent eagerness at one time and neglect it at another. The composition of plants as affected by soils, stage of maturity, the species and varieties, and the need of the animal for food probably have a bearing on palatability. Plants containing relatively high percentages of minerals seem to be preferred. Grass growing in sunlight is more nutritious and more palatable than that growing in shade.

Some young, tender grasses may be eaten in preference to legumes, but when the grasses become more mature the legumes may be preferred to the almost total exclusion of the grasses. Some weeds, such as dandelions in the spring of the year, may be eaten with great relish in preference to grasses. On the ranges sheep eat a vast variety of plants, but some are neglected at certain periods except when feed is scarce. Because of their mobile lips, sheep are able to be very selective in gathering feed. A two-acre field of different varieties of brome grass was grazed by sheep. Plants of some varieties were scarcely touched until after those of other varieties in adjacent plots were entirely consumed. This may have been associated to some extent with differences in maturity.

Seventy observations were made at the Illinois Station at regular intervals of the number of sheep grazing on six different plots during a four-day period, May 4 to May 8, 1938.[1] The type of vegetation and the distribution of sheep were as follows:

TABLE 22

PREFERENCE SHOWN BY SHEEP FOR VARIOUS PLANTS DURING A FOUR-DAY PERIOD

Plot	Vegetation	Number of sheep on plot
1	Ladino clover	44
2	Timothy	26
3	Reed Canary grass	0
4	Alfalfa, timothy, and redtop	30
5	Kentucky bluegrass	5
6	Redtop	5

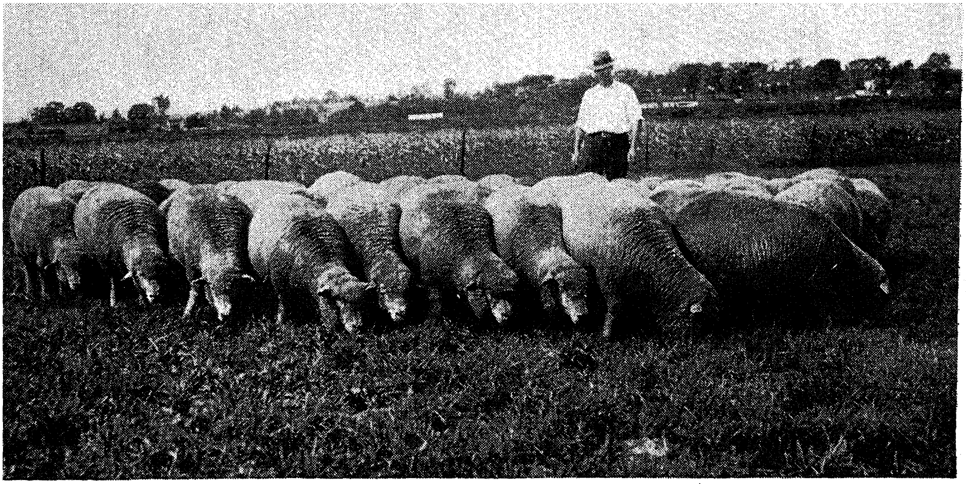
[1] FUELLEMAN, R. F. and BURLISON, W. L. Palatability of Pasture Plants. Ill. Acad. Sci., Vol. 34. No. 2. 1941.

PASTURES

None of our domesticated animals surpass sheep in their need for, and their ability to utilize, pastures. Pastures and ranges are the natural habitat of sheep, and they thrive on them under an extremely wide variety of climatic conditions and utilize the most diverse types of vegetation. Even though there are great differences in plants, sheep are able to find the necessary nutrients from the grasses, legumes, weeds, herbs, and shrubs that grow on millions of acres of cultivated and uncultivated land in this and other countries. It is primarily because of this use of natural vegetation and the relatively imperishable character of wool that sheep raising has been a frontier, pastoral industry. Sheep raising and a grassland type of agriculture are therefore associated endeavors. Under modern improved agricultural methods, the problems of farm pastures for sheep are quite different from those of the range areas, but there are also many elements of similarity. Under range conditions, sheep raisers move from one section to another in order to provide their flocks with an abundance of palatable and nutritious pastures; on farms the same goal is sought, but the methods are directed toward the control of the vegetation, and the enterprise is usually on a much smaller scale.

In the Central States farm flocks utilize about 13 acres of pastures and roughages for each acre of grain. Throughout the range areas the pastures are depended upon to an even greater extent. Except in the case of purebred flocks, it is unlikely that most farm ewes can be profitably fed more than about 100 to 125 pounds of grain annually.

Ranges or pastures in western areas are frequently described according to the season of the year when they are used, as spring and fall, summer and winter. In the mountainous sections the summer ranges are usually at high altitudes, the spring-fall grazing is at intermediate altitudes, and much of the winter range is on the desert or lowland areas. In some places the same range is used the entire year and is called year-long pasture or range. Use is also made of cultivated sections, where the sheep eat crop by-products and aftermath. Irrigated lands produce very productive pastures of clovers and alfalfa. The vegetation on these various areas differs greatly. The summer ranges provide many palatable grasses and other plants, grazed when in the most nutritious and digestible stages. Some of the winter grazing areas are characterized chiefly



Courtesy University of Illinois

High-yielding, nutritious pastures are the basis of profitable farm flocks.

by the growth of shrubs, but interspersed among the shrubs are some grasses and leafy herbaceous plants.

Classification of pastures. In other sections of the country pastures are classed as permanent, rotation and temporary, emergency or supplementary. The permanent pastures are mainly grasses, although many other plants are found in them. These areas, if cleared and if not too rolling or otherwise unsuitable, are called plowable pastures; or if there is considerable timber, they are called woodland pastures. The latter are much less valuable from a pasture standpoint than those growing on cleared lands. Rotation pastures are usually more productive than permanent pastures, as they are grown on land used in the regular cropping sequence of the farms. The part of the crop land in rotation pastures is generally used in this way for one, two, or three years. Temporary pastures occupy an area for a part of the year and usually are composed of quick-growing crops such as Sudan grass, rape, annual legumes, or some of the cereals. They are very useful adjuncts on farms where sheep are raised and climatic conditions are such that permanent and rotation pastures are not thoroughly dependable during the summer months.

Permanent pastures. Permanent pastures vary much in the number of sheep that can be pastured per acre. The best pastures are those that carry the largest numbers and yield the greatest amount of animal products. The variation in these respects is related to the soil, rainfall, and temperature. The amount of product obtained is also related to the manner of handling the sheep and

the pastures. From the standpoint of sheep husbandry, one of the most important features of pasture management is the utilization of the vegetation when it is most palatable and nutritious. To get the most benefit from pasture, some of the grasses, such as bluegrass and others that grow best in the cool spring and fall days, should be grazed during those seasons. Other actively growing plants should be grazed at other seasons. In all localities there are grasses and legumes which can be used to provide such sequence. Sheep prefer succulent, fine, short grasses rather than the coarse, high-growing kinds, but much depends upon the stage of maturity. Succulent forage produces the greatest thrift, promotes the heaviest secretion of milk, and results in the largest gains in weight, especially on lambs.

Grasses. Pasture grasses include many species of which seed is not available commercially. Hitchcock [1] includes in The Manual of Grasses 1,100 species in this country. New species are introduced from time to time, but probably not more than 2 or 3 per cent of the above number are widely used for seeding in pastures. Native and introduced legumes are likewise numerous, but relatively few are cultivated and used for pasture purposes where seeding for improvement of old pastures or for the establishment of new ones is undertaken. No one specie of grass is adapted for use in all sections of the country, and selections must be made with that fact in mind. In the northern states and outside of the drier western sections the number of adapted grasses is greater than for the other areas. Kentucky and Canada bluegrass, redtop, timothy, orchard grass, brome grass, and rye grass are most common. In the western parts of this northern area, brome grass, crested and other wheat grasses, and tall oat grass are probably most frequently used. In the southern sections the most important are Bermuda grass, carpet, and Dallis grass. There are other grasses of importance in various areas, but they are either not sown for pastures as they are part of the native vegetation or do not seem important in sheep raising.

Kentucky bluegrass. Kentucky bluegrass is probably the most widely distributed. In many sections it comes into fields without being seeded. It is best in the spring and fall, as it is dry and fibrous during the months of July and August and is then unpalatable. It stands heavy grazing and is useful as winter grazing or a feeding ground. In an active growing stage it is very palatable,

[1] Hitchcock, A. S. U.S.D.A. Misc. Pub. 200. 1935.

may contain more than 20 per cent protein and large amounts of other nutrients. Canada bluegrass is more suitable for poor soils than Kentucky bluegrass. It is a little later, also, but apparently equally palatable and nutritious.

Brome grass. Brome grass is a very productive pasture for sheep and provides a long grazing period. While drought resistant, it does best on good soil. It is palatable to sheep, but no more so than some of the other grasses, and, like that of others, its palatability varies with its stage of maturity. It has carried almost twice as many sheep and produced almost twice as much gain per acre as bluegrass.

Redtop. Redtop is probably second in distribution to bluegrass. It does better on poor soil than bluegrass, but the best redtop pasture is on good soil. It is a little later maturing than bluegrass, and hence there are periods when it is more palatable to sheep.

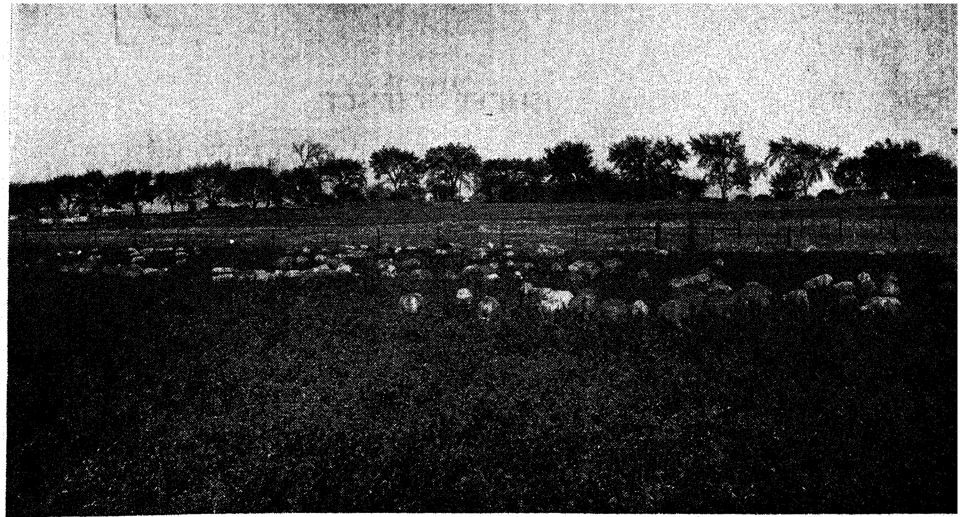
Orchard grass. Orchard grass is a tall-growing bunch type that is supposed to be among the best for areas where there is considerable shade. It is only of medium palatability, but it may be eaten very readily in comparison with some other types of forage. In comparison with brome grass it is much less productive of increases in weight.

Timothy. Timothy is the best of the hay grasses that are used for pasture. It is very palatable when young but unpalatable when mature. It will not persist under severe grazing. Few grasses, however, will do so, as even quackgrass will be reduced if heavily grazed continuously. Rye grasses provide very early, fairly palatable pasture in regions where adapted.

Bermuda grass. Bermuda grass is a summer grass, as it comes on late in the spring and does not grow after frost. It is a southern grass of low to medium palatability to sheep.

These grasses and others are frequently used in mixtures, of which there are many different combinations. Pure stands of any of the grasses are not likely to exist for a long time, as wild grasses invade the areas. Some, such as the spear or bearded ones, are very undesirable, although they may be eaten by sheep at certain seasons, and some of them may be rather nutritious.

Mixed pastures. Mixed pastures are often more productive than a single grass and may be safer than a single legume. If judiciously grazed, there is much more likelihood of a mixed pasture affording good feed throughout the season than if a single grass is



Courtesy University of Illinois

Alfalfa is an excellent pasture or hay crop for all classes of sheep. Careful management reduces the danger of bloat.

used. It is impossible to make recommendations for mixed pastures because of the great variations needed to meet different soil and climatic conditions. There are innumerable possibilities for different combinations of species and varieties and in the amounts of seed that will best meet local requirements.

Legumes. Legumes, like the grasses, are of many different kinds, but few of them are used in seedings for pastures. The legumes in permanent pastures are mainly clovers, although alfalfa may also be included, especially in some areas. Legumes have two values in sheep pastures. They are generally palatable and nutritious, and they benefit the grasses through the addition of nitrogen to the soil. The best permanent pastures for sheep contain some kind of legumes. The two objections to them are that the seed is often expensive, and there is sometimes more tendency for sheep to bloat on legumes than on grasses. There is no highly uniform tendency in this respect though in the case of all legumes.

Alfalfa. Alfalfa is one of the most productive pastures for sheep. Close grazing continuously will soon ruin the stand, but if grazed heavily for a short period and then given a rest period for recovery, it will stand pasturing for several years. It is one of the very best of summer pastures. Grazing fully matured alfalfa fails to utilize its full feed value. That which is not extremely succulent is perhaps less likely to cause bloat than young plants early in the spring. Alfalfa is frequently grazed both night and day and wet or

dry without trouble from bloat, but at other times there may be difficulty in this regard.

Clovers. Clovers have been used for pastures for many years. Bloat may occur in sheep on clover pastures. Red clover, alsike, and sweet clovers are principally used in rotation rather than permanent pastures. White clover is very often found in pastures where it has not been seeded. Ladino clover is a large type of white that is more productive than the smaller kinds and is highly esteemed in certain areas, especially in the irrigated sections of the West and in some parts of the central and eastern states. It is increasing in popularity in the Corn Belt.

Lespedezas. Lespedezas, which are valuable for pastures, are annual plants that maintain themselves by reseeding each year. They are lower in moisture than alfalfa and clovers and seldom if ever cause bloat. They are palatable and very nutritious and where adapted form valuable pasturage for all classes of sheep.

Other types such as bur clover and hop clover, as well as other legumes, are important in limited areas.

Mixtures of one or more grasses and legumes are among the most productive pastures.

In many parts of the midwestern states the mixture of alfalfa and brome grass will give very satisfactory results with any class of sheep. Michigan State College [1] secured the following gains on different pastures.

TABLE 23

COMPARATIVE GAINS ON PASTURES

Kind of pasture	Gains per acre	Sheep-days per acre
	lbs.	
Alfalfa-brome grass	362	1,032
Alfalfa	309	1,032
Alfalfa-orchard grass	251	1,041
Orchard grass	54	504

At the Illinois Station [2] studies show the importance of legumes in pastures and also show the significance of good management practices. Rainfall and seasonal conditions have great effects on pasture yields. Likewise, the management of sheep on the pas-

[1] Mich. Agr. Exp. Sta. Cir. Bul. 189.

[2] FUELLEMAN, R. F. et al. Jour. Am. Soc. Agron. Vol. 36. No. 10. 1944.

ture has much to do with gains. When alfalfa and brome grass have been grazed continuously or with alternate grazing and rest periods, the gain in weight on sheep has been much in favor of alternate grazing. Continuous overgrazing damages pastures and fails to yield worth-while increases in animal weights.

TABLE 24

AVERAGE ANNUAL FORAGE PRODUCTION, PASTURE-DAYS, AND GAINS ON SHEEP PER ACRE OF PASTURE DURING A 5-YEAR PERIOD [1]

Kind of pasture	Dry matter	Gains	Sheep-days per acre
	lbs.	*lbs.*	
Alfalfa	6,782	270	1,507
Alfalfa-brome grass	7,481	250	1,604
Brome grass	4,368	136	821
Alfalfa-orchard grass	5,630	193	1,474
Orchard grass	2,904	130	837

Rotation pastures. Rotation pastures are based largely on single grasses or single legumes or mixtures of grasses or of legumes or of grasses and legumes.

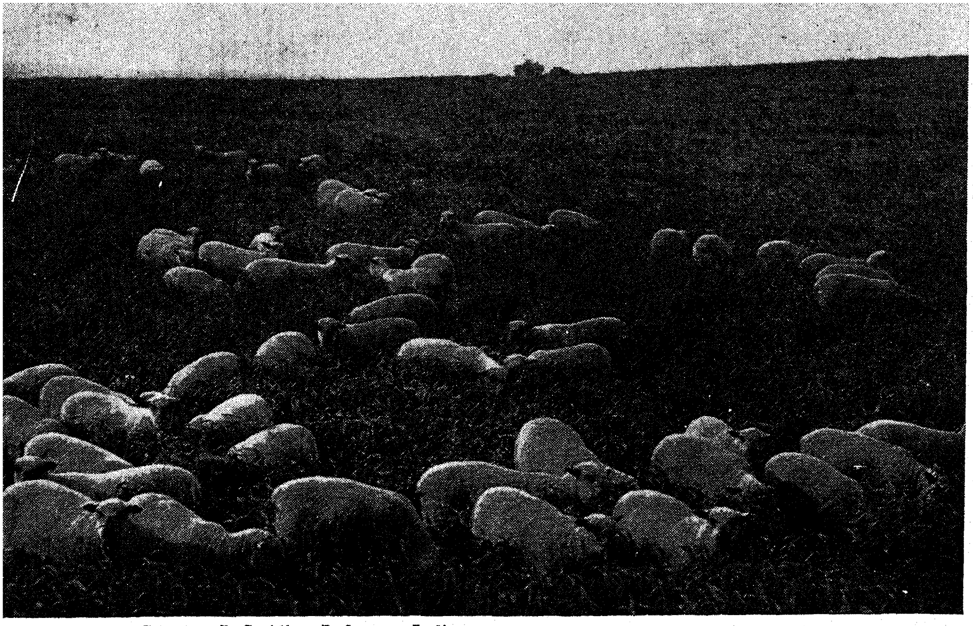
Temporary pastures. Temporary pastures are usually of a single species, although some mixtures are used.

Wheat. Of the cereals sown for this purpose, wheat is probably more widely used than any other. Many sheep are pastured on the large wheat fields of the western states. The wheat is sown for the purpose of raising a grain crop, but it does furnish valuable pasturage, and when not too heavily grazed, the subsequent grain production is not lowered. In some sections the seeding is primarily for use as forage. It is, of course, mainly for winter and early spring use, when little other succulent feed is available in the fields.

Rye. Rye is good pasture for winter and spring. In some places a variety known as Balbo rye is found to make better and more feed than common rye. Rye must be kept grazed down so that it does not joint, or it becomes low in palatability.

Winter barley. Winter barley and oats are also used as pastures but to a much less extent than wheat and rye. Sheep that have been fed considerable grain during the winter months will not make good gains on cereals or grass. Those that have been on dry

[1] FUELLEMAN, R. F. et al. Jour. Am. Soc. Agron. Vol. 36. No. 10. 1944.



Courtesy J. C. Allen, Lafayette, Indiana

Pastures grown in the regular crop rotation are often highly productive.

roughage will often make almost phenomenal gains on cereals in the springtime.

Rape. Rape is a common temporary pasture crop in northern states. It is adapted to fertile soil, and it is always a disappointment on poor soil. Rape is palatable and nutritious, but it sometimes causes scouring as it is very watery. Rape can be grazed with less waste if it is planted in rows. It may be pastured after frosted, especially if the sheep have been grazing on it previously. Many sheep raisers prefer to use some dry feed along with rape as a precaution against scours and occasional bloat. If dry feed is not used, rape is best used with an adjoining field of grass.

Oats and peas. Oats and peas make a good temporary run in cool areas. This is another of the grass and legume combinations highly prized by some sheep raisers.

Sudan grass. Sudan grass is a very rapid-growing summer pasture. After growth is well started, it is drought resistant. It may be poisonous when very young or when wilted or frosted. At other times, after it has attained a height of about six or eight inches, it is a safe and productive feed. On fertile soil and with good moisture conditions, an acre of Sudan grass will carry fifteen or more sheep to an acre for about a two-month period. It is also used as a hay and silage crop.

Soybeans. Soybeans are often sown with Sudan grass in the Central States. The soybeans make a fairly good forage crop, but after being grazed off rather closely, recovery is slow. Many soybeans are planted with corn and used for fattening lambs in the fall of the year. The leaves and the beans in such cases furnish protein for the lambs where lambing down corn is done. Soybeans alone are best if sown in rows about 15 or 18 inches apart.

Cowpeas and velvet beans. Cowpeas and velvet beans provide grazing similar to that obtained from soybeans and are handled in a similar way.

Some advocates of temporary pastures recommend a succession of crops so that the sheep may graze such areas much of the year. Such a system may find favor with those who specialize in the production of purebred animals or strive for a special market, but most general farmers who have a flock of sheep as one of their farm enterprises will adopt rotation pastures in preference because there is less specialized work, fencing, and seeding needed, and the results are not likely to be sufficiently in favor of the succession of temporary pastures to make that system attractive to many producers. Under a plan of highly specialized and intensive sheep production, the succession of various crops would have some advantages. Before the discovery of phenothiazine for the control of internal parasites of sheep, the plan had some additional advantages as an aid in parasite control, which is not now of so much importance. There can be no doubt that the improvement of permanent pastures and those produced in the usual crop rotation sequence would be of immense benefit in many sections and would reduce the need for temporary pastures to a very large extent. Many of the permanent pasture lands are the poorest portions of farms. Some attention toward the improvement of the soil on these parts of farms would benefit sheep raisers by greater carrying capacity and higher-quality forage.

HARVESTED ROUGHAGE

In regions where good pastures are not possible for the entire year, the harvesting and preservation of roughages are matters of importance. Whether roughages are stored as hay and fodders in the dry state or preserved as silages with a high moisture content, there are some losses of nutrients. Grasses and legumes are commonly stored as hay, while corn and sorghums are handled as silage

or as fodder. Because of the impossibility or difficulty of making good hay when unfavorable weather exists and because some nutrients are preserved much better in silage than in hay, increased attention has been given recently to the ensiling of grasses and legumes.

HAYS

Grass hay. Hays are the standard winter feeds for sheep when they are not on pasture. Even in the range areas where the sheep are out-of-doors most or all of the year, enormous quantities of hay are fed to bands of sheep to provide them with more feed than they can gather from the winter feeding areas. Winter pastures of mature grasses are not so nutritious as pastures of immature grasses at other seasons. If the mature grasses are exposed to rains, a considerable percentage of the minerals and nitrogen compounds are soon leached out. Weathering and exposure to sunlight also greatly decrease the vitamin A. Because of these conditions the use of good quality hay or other stored roughages often is an important item in the wintering of sheep.

The best hay is that which has been made from plants grown on fertile soil, cut at the proper stage, dried rapidly so that it retains its green color, handled without the loss of leaves—usually the most nutritious part of the plant, and stored so that it is not exposed to weathering. Some very marked changes may occur during harvesting and storage, especially with respect to the vitamin A content. Losses of 75 per cent of the vitamin A of alfalfa have been reported to occur from the time the alfalfa was cut until it was cured and reached storage. There may be further significant decreases during storage. Rainfall on hay is very damaging to its nutritive value. Even allowing hay to be exposed to sunlight and weather in the swath, windrow, or cock may reduce its value. The ideal way of hay making would be to dry the plants rapidly as they are cut. No highly practical and economical method of artificially curing hays has been developed and put into extensive use.

Great as the losses of nutrients may be because of exposure and moderate weathering, the losses due to the shattering of the finer parts of the plants and the mechanical loss of leaves on account of poor methods of handling may be as great or even greater. In the making of hay for sheep, special care should be taken to save the leaves, for these are the highly nutritive parts of all the legumes

and grasses. Stemmy hay with few leaves is of low quality, and there is no way to restore the nutrients lost in the leaves. This is true also of such crops as corn when harvested as fodder or stover, for here, too, much of the feeding value is found in the leaves. Very often the fodder is allowed to remain in the field where the wind blows away many of the leaves, and the rains leach minerals and other nutrients.

Legume hay. Legume hays are unsurpassed for sheep and are far superior to hay from the grasses. As indicated above, however, there are great differences in hay from the same plant species, and it is possible to have grass hay of exceptional quality that is better than very poor quality legume hay.

Legume hays are characterized by high palatability, high protein and calcium content, and usually, if of green color, by ample vitamins. Sheep have been maintained for very long periods on no feed other than legume hay, salt, and water.

Alfalfa. Alfalfa is unexcelled by any other hay, and it is usually taken as the standard for comparison. The sheep raiser who has an abundance of alfalfa hay is in a fortunate position, for he needs little beside corn or a similar concentrate to provide satisfactory rations for all classes of sheep at all seasons of the year when they might not be on pastures. The finer stemmed, greener, and leafier the hay the better. The chief difference in the value of the various cuttings seems to be associated with the relative stemminess and green color of the hay. Special preparation of alfalfa hay is usually advisable only for certain types of feeding. An example of this is the self-feeding of lambs when the concentrates are best if mixed with chaffed or ground hay as a means of preventing overeating. Cutting or chaffing hay when it is made reduces the storage space required and may make feeding easier.

Red clover hay. Red clover hay is an excellent feed for sheep but does not have as high a protein content as alfalfa and is therefore generally not fully equal in feeding value. In all comparisons the yield per acre, ease of growing, and other factors should be considered from a practical standpoint. Clovers are usually more suitable for short crop rotations; whereas, alfalfa is a high yielder, and under the very best conditions the stand will last for a number of years.

Alsike, mammoth clover, and sweet clover. Other clovers, such as alsike, are suitable for sheep. Mammoth clover is generally

too coarse and stemmy. Sweet clover has a high value if not stemmy, but this condition is so seldom found that it is not widely used as a hay for sheep. Since sweet clover may show a very wide range in quality, the relative value compared with alfalfa may vary from about 50 per cent to almost 100 per cent. If sheep are affected by "sweet clover disease" (failure of the blood to clot), few such cases have been reported.

Soybeans. Soybeans are now grown in many sheep-raising sections. The suitability of soybean hay has been shown by many trials and extensive use on farms. For all classes of sheep, except young lambs, good-quality soybean hay may be expected to give as good results as alfalfa. However, because soybean hay is far more stemmy, it will require about one-fifth more soybean hay than alfalfa hay to produce the same results. Since the stems are coarse and fibrous, there is very little feed value in them, and the best way to feed soybean hay is to feed it in such amounts that the sheep need not eat the stems. Grinding or chaffing the hay so the stems will be eaten is not advisable either from the standpoint of economy or nutrition. Since soybeans are a late-maturing crop, there is often some difficulty in curing the hay. For sheep the soybean plant should be cut when the beans are about full size, but the lower leaves have not fallen. The beans and the leaves are the two main nutritive parts of the plant. Cutting at that time not only makes the most palatable hay, but the yield of nutrients per acre is larger than if the plants are cut when the beans are small. Tests have shown no harmful results to either breeding ewes or fattening lambs when as much as 38 per cent of the total soybean hay ration was made up of beans.

Lespedeza. Lespedeza (Korean) makes an excellent hay for sheep, and if of good quality it will be found the equal of similar alfalfa. It is higher in protein and digestible nutrients than red clover. It is not adapted for use throughout the country, but where it is grown it may be used alone or in combination with the grasses to good advantage. Because the plants contain less moisture than alfalfa, it is readily cured. Perennial species such as sericea are not at this time considered of much value for sheep.

Cowpea hay. Cowpea hay is very rich in protein and, if well cured, is a good hay for sheep. Many other legumes are grown for sheep, but the most extensively grown are vetch, field peas, and kudzu. Often the two former are grown with other crops.

Nonlegume hay. Although legume hays are far superior in many respects to the nonleguminous hays, the latter are important in sheep-raising and lamb-feeding areas. If these hays are made from immature plants, they have a higher feeding value than if cut at the usual late stage of maturity. Even if cut early they are, however, lower in protein, calcium, and vitamins than legumes; and hence for best results, it is advisable to use supplementary feeds along with them. Even with such supplements it is unlikely that the results will be fully equal to those obtainable with the legumes. Most of the grass hays are less palatable to sheep than are legumes. Because of these differences grass hays combined with the legumes are more satisfactory than the grasses alone. Indeed, if the two are grown together, it is likely that the nutrient content of the grasses, especially the protein content, will be higher than if the grasses are grown alone.

Timothy. Timothy is widely used as a standard among the grass hays. It may vary from as low as 2 or 3 per cent protein to almost 6 per cent, depending upon the stage of maturity and manner of curing. As an unsupplemented feed most sheep raisers consider timothy about the equal or only slightly above the value of oat straw. However, much depends upon its quality and the soil upon which it was grown. It is not highly palatable.

Prairie hay, bluegrass hay, redtop hay. Prairie hay, bluegrass hay, redtop hay, and hays from similar grasses are finer stemmed and may have a slightly higher value in some cases than timothy. All of them need supplementing. Similar results are generally secured when such hay as millet, Sudan grass, brome grass, and so on are used. Although a great variety of low-grade grasses and even weeds are sometimes used for sheep, such things certainly cannot be recommended as a part of modern sheep husbandry. Of course, there are emergencies when recourse to very poor feeds is necessary. In all such cases care should be taken to supply the supplements to properly nourish the animals or to approach such nourishment as closely as possible.

Cereals. Cereals, especially oats, are frequently cut early—about the time when the kernels are in the milk or dough stage—and make fairly palatable and nutritious roughages. Oat hay may contain as much as 5 per cent digestible protein and around 47 per cent total digestible nutrients. Oat hay should not be depended upon as the only feed for sheep. Instead of being handled as a hay

crop, oats are sometimes cut and fed as sheaf oats. The oats in such cases are more mature, although the best sheaf oats are not so ripe as when cut for threshing. The grain and straw together make a useful and palatable feed, which usually should be supplemented with calcium and a small amount of protein concentrate or with some legume roughage.

STRAW AND FODDER

Straw of all kinds is used to some extent for feeding. The value of straw varies widely, depending upon the plants from which it was made and whether or not it is bright and well cured and leafy. Straw from the legumes, after threshing, is probably the highest in value; but there are many factors that may reduce the value of such straw or chaff to the level of that from the small grains. The best use for any kind of straw for sheep feeding is as part of the ration for animals that are being maintained rather than grown or fattened. For ewes that are bred, straw may be used for part of the ration in the early part of the gestation period; but certainly little use should be made of any such feed as lambing time approaches.

Straw from clovers or alfalfa is of higher value than that from the coarser-stemmed legumes such as soybeans. Straw from these legumes may be considered as having a value from about one-quarter to one-half that of the hay from the same plants. Rather than make animals eat all of the straw offered them, they may be allowed to pick over such materials and that which is left used for bedding.

Oat straw. Oat straw is the best of the small grains. It should not, however, be considered as a feed of high quality, as it is very low in protein and other nutrients except fiber. Sheep like the finer chaffy parts, and there may be some economy in letting them eat reasonable amounts, say up to about a third or half of the roughage ration.

Barley straw. Barley straw is next in palatability and value, but the beards may be harmful, especially to woolly-faced sheep. However, the beards may get into the eyes of others as well and may also injure the mouth.

Wheat straw. Wheat straw is not liked by sheep as it is coarse, and there is little leafy material. Rye straw is too woody and stiff and unpalatable to use for anything except bedding for sheep, and it is less desirable for this purpose than the other straws.

Fodder. Corn fodder represents the entire corn plant. In some cases the ears may not be very well developed because the plants were grown close together or the corn was stunted. In other cases the corn was grown principally for grain but harvested by cutting the whole plant and setting it up in the field in the form of shocks. In some areas the latter is referred to as shock corn or bundle corn. If the ears are removed from the fodder or shock corn, the stalks, husks, and leaves that are left are known as corn stover. Fodder is therefore much more valuable than stover. The best fodder and stover are made from leafy corn cut when the stalks are dry enough to keep, for there is no loss of leaves later by strong winds, and none of the nutrients in the leaves are lost through leaching by rains. The stalks are not of much value as feed, and the processing of them by grinding is seldom worth while. This does, however, make them much more suitable for use as bedding, but it does not improve the nutrient content. In some areas the fodder is shredded after it is thoroughly cured.

It is unwise to expect good results from such feeds as corn stover when fed to sheep that are intended for fattening. Corn in the form of silage is much better. The best use for stover is for breeding sheep that are being maintained at about constant weight during the early part of the pregnancy period.

Sorghum fodders. Sorghum fodders and stovers are essentially the same in value as those from corn. All such feeds require supplementing with a protein concentrate and a source of extra calcium. Liberal amounts of legume hays will meet the needs for supplements, but in such cases the amounts of fodders or stovers eaten are reduced below the quantities eaten if no legume hay is fed.

SILAGE

Any crop stored as silage undergoes changes. These changes may or may not be as great as with storage under other conditions. The most noticeable changes in silage are a change from the natural green of the plant to a darker color, the change in shape due to pressure, the development of an odor different from that of the plant, and the change from a mild or sweet taste to a more or less sour taste. Accompanying these changes there has been fermentation of sugars, the formation of organic acids, some of the complex proteins have been converted into simpler and more soluble nitro-

gen compounds, and some volatile products have also been formed. But most of the plant materials have remained unchanged, and the feeding value is about the same as when the silage was made, provided care has prevented the development of objectionable odors or lowered palatability, and the silage has not become moldy.

Silage is generally thought of as a feed of relatively low value, as it is stored in a fresh or wet condition and contains only 30 or 40 per cent dry matter; whereas, hays contain about 90 per cent dry matter. The water in silage or hay is of no more value than water from any other source. The value of the dry matter depends upon its composition, and on this basis good corn silage compares favorably with the best grade of grass and legume hay. A large amount of silage is obtained from a relatively small area, and nine tons require about as much storage space as one ton of loose hay.

Some opponents of silage regard it as detrimental to animals because of its acid content. These silage acids, derived from the fermentation of sugars, are as readily used for food as the sugars. Silage is in no way harmful to sheep, and while it has deficiencies these may be corrected easily. Losses of nutrients during storage as silage are no greater than with other methods of storage, if reasonable care is used. In fact, carotene and some other nutrients of the plants may be retained to a greater extent in silage than in fodders and hays. Because of its succulence, silage is very helpful in preventing the constipated, thriftless condition often seen in dry-fed animals in late winter.

In spite of advantages that it may have, silage has not been a favorite of many sheep raisers. It is safe to say, however, that good silage properly used is one of the best feeds for all classes of sheep. If the flock is small, there may be difficulty in feeding enough silage each day to prevent spoilage; but since owners of small flocks usually have cattle, spoilage from this cause will not often develop.

Silage crops. Although corn is most commonly used, almost any crop—sorghums, cereal grains, legumes, grasses, or a mixture of two or more crops—will make satisfactory silage. Special methods are needed in some cases, and it is generally advisable to have a higher dry-matter content—40 or 45 per cent—if legumes are ensiled. During periods of unfavorable weather, valuable hay may often be saved by use of a silo. Cannery refuse, potatoes, beets, beet tops, sunflowers, and other materials have been made into silage and fed experimentally or under practical conditions.

In making corn silage for sheep, the corn kernels should be passing out of the dough stage and starting to harden, at which time the dry matter will amount to about 30 or 35 per cent of the total weight of the plant. The plants should be cut into one-half to three-quarters inch lengths and be evenly distributed and well packed in the silo. The best silage is made from well-eared corn and thus contains a large amount of corn grain, often 12 or more bushels per ton. From 30 to 40 per cent of a ton of silage will then be corn grain.

Corn silage, or that made from sorghums or grasses, is low in protein and calcium. Other feeds that will increase these nutrients in the ration should be fed. These deficiencies may be corrected by mixing legumes and corn or sorghum when making silage, by feeding a legume hay with corn silage, or by feeding a high-protein concentrate and limestone. In most cases silage will be fed with other roughages, but it may be used as the only roughage for any class of sheep. Tests involving many thousand ewes and fattening lambs furnish the basis for stating there need be no fear in using it in this way. The daily use of a fifth to a quarter of a pound of protein concentrate and one-half ounce of limestone for each ewe will satisfactorily supplement silage for ewes during pregnancy. Ewes of average size will eat from six to seven pounds of silage daily under such conditions and will make equal gains in weight and remain as thrifty as when fed legume hay. They will excel in the cleanliness of the wool because of the lack of chaff. Lambs from ewes fed silage will be fully equal in size and vigor at birth, and their subsequent growth will be as satisfactory as lambs from ewes fed on other rations.

Fattening lambs do well on silage, and it is often recommended as a suitable addition to a ration of grain and legume hay. It usually increases the rate of gain and lowers the cost. When used as the only roughage for fattening lambs, it needs to be supplemented with feeds high in protein and calcium. For the purpose of fattening lambs, additional grain beyond that needed to correct deficiencies should be supplied.

ROOTS

As a special crop for sheep, roots are raised, mainly by producers of purebred animals. In such cases mangels, rutabagas (swedes), turnips, and carrots are usually grown.

Mangels. Mangels, when grown on fertile soils, yield a very high tonnage—in many cases exceeding 40 tons per acre—and although all root crops are high in moisture, 85 to 90 per cent, a large amount of dry matter may be obtained per acre. Mangels are relatively easy to grow and harvest, as much of the plant is on top of the ground; most of the other plants grow deeper, and it is generally necessary to plow them out at harvest. Mangels withstand drought and heat better than most roots and will keep for long periods if not bruised and if stored in a well-constructed root cellar.

Rutabagas. Rutabagas seem to be preferred by sheep. They are not grown to any extent except in the northern states, as neither they nor turnips do well in warm sections. Carrots are not often grown especially for sheep, but they are apparently higher in some of the vitamins than other roots and are considered good feed by sheep raisers.

Sugar beets. In several areas sugar beets constitute an important feed for sheep, although they are not raised primarily for this purpose. Sugar beets are generally fed in the form of pulp which is the residue from the manufacture of sugar. This may be fed as either wet or dried pulp. It is commonly fed with alfalfa hay, but when used in large quantities, it is advisable to use a protein and phosphorus supplement with it. To store the wet pulp it is usually ensiled; however, it is often kept by simply putting it in huge piles. Much of the water and nutrients are lost in this way, although there are also losses of nutrients when it is put into silos.

Beet tops. Beet tops are fed to many fattening lambs and to sheep. The tops are cut from the beets at harvest and are usually put into piles or are ensiled. Lambs are turned into the fields to eat the tops, or after the tops have dried partially, they are hauled to the feed yards. The tops are laxative, and some other dry roughage should be fed with them.

The dry matter of roots. The dry matter of roots is of high nutritive value, and roots are generally credited with having a beneficial effect on the digestive system. Roots are generally fed sliced or pulped, although some are fed whole. In this country about 4 or 5 pounds is the usual maximum rate of feeding, but elsewhere 12 to 14 pounds are often allowed daily to an ewe.

For many years sheep raisers have been cautioned not to feed roots to rams or wethers because of the danger of causing renal or urinary calculi. Experience and experimental work do not sup-

port this view. Most sheep that have this trouble are not fed roots.

Other crops. Other crops such as cabbage and pumpkins are used in localities for show sheep, but there are sections where cabbage is fed to fattening lambs. Cull potatoes, onions, and other vegetables are sometimes fed. Sunflower silage finds favor in restricted areas. In fact, there are few crops that are not fed in at least limited amounts in some section to sheep; but these feeds are not of commercial importance.

CONCENTRATES

The concentrates most frequently used for sheep are the common farm grains, oats, corn, and barley being the most important. Wheat, rye, the seeds of some of the grain sorghums, and some minor crops are also fed. Products of the milling industry and of other industries are also used, but these are generally fed in limited amounts as protein supplements. The most extensively used protein supplements are linseed oil meal, soybean oil meal, cottonseed meal, corn-gluten feed, wheat bran, and screenings. The latter are not strictly a protein supplement, as the composition varies widely. Molasses is sometimes extensively used by lamb feeders, and a number of by-products not listed here are fed in limited amounts in various areas.

Oats. Oats are the preferred grain for breeding flocks and for growing lambs. Oats are palatable, and because of their bulk they are considered the safest of the grains. They are not extensively used as the only feed for fattening lambs or sheep, for they are considered more suitable for the production of growth than fat. When compared with corn for fattening, they have a value of about 65 to 80 per cent of that of corn per pound. Because of their relatively high price, the use of oats usually adds to the cost of the ration. Their bulk serves to lighten otherwise heavy rations, and for that reason, they find favor with lamb feeders, especially during the first part of the feeding period. The use of oats reduces the amount of roughage eaten. Whole oats are satisfactory for all classes of sheep, and there is no advantage in grinding them.

Corn. Corn is the great fattening grain in the United States. It is very high in nitrogen-free extract, approximately 70 per cent, most of which is in the form of starch. It is very low in fiber, and its nutrients are highly digestible. It is not high in protein or minerals, and for these reasons it is advisable to use it with legume roughages

when fed to sheep. If this is not done, then appropriate amounts of minerals and protein supplements should be fed to correct its deficiencies. This may be readily done through the use of any of the meals and the use of feeding grade limestone; calcium is the mineral that is most likely to be deficient in rations which do not contain legumes. The various products of the corn-milling industry, such as corn-gluten feed, corn-gluten meal, hominy, and so on are used as sheep feeds, but such use is for the most part restricted to fattening lambs in areas where farm grains are not produced in great abundance.

Corn need not be ground for any classes of sheep except very old ewes and young lambs under six or eight weeks of age. There is an advantage in grinding corn for fattening lambs that are being self-fed, in which case the grain is mixed with cut or ground roughage as a safety factor to prevent the lambs from overeating on corn.

Some sheep raisers have considered corn as a poor feed for breeding sheep and have ascribed many difficulties to its use. If fed to excess, it may cause digestive troubles because it is heavy and compact. But if fed in reasonable amounts and if its deficiencies in mineral and protein are properly corrected by feeding legume roughages or high-protein concentrates and a mineral supplement that will meet the needs for these nutrients, there is no danger whatever in its use. In fact, in the light of recent research on one of the frequent difficulties of the pregnancy period, so-called lambing paralysis or pregnancy disease, corn is one of the best feeds to use during that period, as it provides readily available carbohydrates which are needed by ewes at such periods as the last few weeks of gestation.

Corn is fed in several different forms. To many flocks of breeding ewes on farms, it is fed as ear corn. For some it is ground or shelled. Fattening lambs are fed shelled corn to a greater extent than in any other form, although large amounts of ear corn, broken ear corn, ground corn and cob meal, ground corn, and the entire corn plant in various forms are also fed. Experimental studies show that there is no advantage of any of the forms over shelled corn. Careful feeders see no advantage of shelled corn over ear corn. In fact, it is difficult to see why there would be any advantage to the various forms if similar amounts are fed, for it is seldom, indeed, that any of the grains pass unmasticated and undigested through sheep.

Barley. Barley is used extensively for sheep outside the Corn Belt. Barley is not high in protein, although it is somewhat richer in this regard than is corn. Except when fed with legume roughages, it is advisable to supplement barley with a protein-rich concentrate. For fattening lambs, barley generally has a value equal to about 85 or 90 per cent that of corn per pound. This value varies considerably, depending upon the quality of the barley, but an average value based on the results of numerous lamb fattening trials shows barley 87 per cent as valuable as corn. Only in case of the bald or hulless barleys which are very hard is it advisable to grind this feed for sheep. Grinding or rolling is often reported as reducing the palatability and resulting in lowered rate of gain on fattening lambs. A few trials show no particular advantage of mixing barley and corn during the fattening period.

Wheat. Wheat is considerably higher in protein than the other farm grains, but it varies greatly in this respect because of the influence of climate. Although wheat has a low content of calcium, it is one of the highest-ranking grains in phosphorus. It supplies no appreciable amounts of vitamins needed by sheep.

Price is one of the main considerations in the feeding of wheat to sheep, and it is seldom used unless it is of low value for milling purposes. For fattening lambs, it compares favorably with corn, as the gains are almost as large, and the feed per unit of gain is only slightly greater with wheat. Wheat is generally worth more than barley per pound for sheep feed. In feeding wheat, there is some tendency for lambs to go "off feed." Some wheat will pass through lambs undigested, and for that reason, it is usually fed ground, although it is often less palatable ground than whole. Most feeders prefer wheat ground to only a medium fineness and mixed with one or more other grains. Even if it is somewhat richer in protein than corn, some protein concentrate is advisable if wheat is to be fed with nonlegume roughages.

Rye. Rye as a feed for sheep does not have a high rating, and the results obtained from its use are not uniform. In some trials, however, rye has had a value comparable with that of wheat and barley. It is usually eaten readily and is preferred unground.

Grain sorghums. Grains of the grain sorghums are used extensively in the western and southwestern sections of the country as feeds for sheep. There are many kinds of these sorghums—such as milo, kafir, feterita, darso, hegari, and sorgo; most of them have

a value comparable with that of corn. These sorghums may be fed as threshed or unthreshed grains, ground or unground. In all cases the results will be about the same if the same amounts of the grains are consumed. In all tests the grain sorghums have shown a higher feeding value than the seeds of sweet sorghums.

Grains such as emmer, millet, buckwheat, et cetera have never become of any special importance in sheep feeding, but they are used in some areas.

PROTEIN CONCENTRATES

Linseed oil meal, cottonseed meal, and soybean oil meal are now the three leading protein concentrates used to supplement the commonly used rations for sheep. Other products are used but to a much lesser extent than these. The relative values of meals—such as peanut oil meal, coconut meal, sesame meal, distillers' dried grains, brewers' dried grains, and others—are closely related to the percentages of protein which they contain. Even fish meal, meat scraps, and tankage have been used for fattening lambs, but they have never come into extensive use, since they have higher values when fed to and are more suitable for other animals.

Linseed, cottonseed, and soybean meals. Linseed, cottonseed, and soybean meals are excellent for all classes of sheep. Since there seems to be little difference in value in the proteins from various sources, the relative values of these materials are very close to the respective protein contents. Hence, in purchasing these materials, it seems that the best basis on which to purchase them is the cost per pound of protein rather than the cost per pound of meal. Since it has been shown in many cases that legume roughages of good quality supply ample amounts of protein for sheep when such roughages are liberally fed, it is unnecessary to buy meals or other protein-rich supplements to add to such rations. That is why, with the usual price relationships, a ration of corn and legume hay is one of the most effective and economical to use for fattening lambs. The meals are most useful and necessary for sheep when nonlegume roughages are fed. Indeed, in such cases, good results are seldom secured unless protein supplements are used. Satisfactory results may be obtained with rations that supply much larger amounts of protein than the minimum amounts recommended, and there may be no harm in feeding large amounts of the various meals. Often the supply is limited and the price high, however.

In general, mixtures of two or more of the protein concentrates are not superior to any one alone in feeding value if the supply of protein is the same in all cases. In no case would any superiority be expected unless the quality of the protein of one of the ingredients of the mixture was very poor. But there is no evidence to indicate that protein quality is of much consequence in sheep feeding. From evidence available at present, one is justified in saying that amount of protein is of greater moment than quality of protein in the case of sheep.

Wheat bran. Wheat bran is fed, to a limited extent, to purebred flocks for its laxative and conditioning effect. It is especially suitable for use as a part of a ration because of its bulk, which is always a consideration of importance in sheep feeding.

Screenings. Screenings are a favorite of many lamb feeders. Because of the extreme variations in the content of screenings, it is impossible to make definite statements about them. Some screenings are so light and chaffy that they resemble straw, while others are almost wholly broken grains and heavy-weed seeds. Judgment is, therefore, an important factor in their successful use. Very light screenings are sometimes used to replace roughages and to supply bulk in rations of fattening lambs that are self-fed.

CHAPTER 30

Feeding and Management Practices

The successful feeding of sheep requires a procedure that provides a ration physically and chemically suited to their needs, an abundance of salt and water, regularity, and cleanliness. The chief essential from a physical standpoint is to meet the requirement for bulk. Extremely concentrated rations are not suited for sheep. An exact balance chemically is unattainable under practical conditions. When unrestrained as on pasture, the day by day routine of sheep is followed with considerable regularity, and this is not overlooked by careful flockmasters when the flock is fed on harvested feeds. Sheep are rather fastidious in their eating habits, and they dislike damaged feeds or eating from soiled or dirty feed racks.

Preparation of feeds. There is little need for special preparation of feeds for most classes of sheep. They masticate their feed very thoroughly during rumination. Practically no whole grains, except a little wheat or rye, pass through the digestive tract. Wheat and rye are not extensively used for sheep, and there is little need to grind other grains except some of the extremely hard types of corn and barley. Even small weed seeds are crushed and prepared for the action of the digestive juices during rumination. The processing of feeds adds no nutrients to them, and all that can be accomplished through processing is increased consumption and greater digestibility. But these are not always assured. Sometimes grinding lessens palatability. In some cases ground grains may be a little safer to feed than whole grains, especially when large amounts are being fed. Grinding may also facilitate mixing several grains, which, if fed whole, would not all be eaten equally well.

Grinding would be recommended for young lambs and for old sheep that have lost some of their teeth. Generally, it is a better practice to cull such old animals, for even with special care they cannot produce efficiently, and the increased value of the feeds to them through grinding may not any more than offset the cost of

preparation. Another instance where special preparation would be advisable is in the case of the self-feeding of fattening lambs.

Cutting, chaffing, or grinding. Cutting, chaffing, or grinding roughages in order to induce sheep to eat more of the stemmy parts is not economical. Since the finer parts would be eaten without preparation, all of the costs of processing should be levied against the parts not eaten when the plant is not processed. Hence, the only occasions when this is likely to be desirable are those when there is need for increased consumption of bulk which can be obtained by grinding or cutting. In the case of fattening lambs that are being self-fed, this may be an important consideration.

Although the practical feeding of sheep is not always consciously based on the scientific principles set forth in preceding chapters, nevertheless the animals' requirements are met, and it is fortunate that the fulfilling of these needs is not generally a difficult task. The economy with which this may be done is a matter of constant consideration. It has been emphasized that sheep are superior grazing animals and that pastures constitute a high percentage of their feed. Few sheep are fed individually, although the basis of feed requirements is the individual. The flock is fed as a unit, or it is divided for feeding on the basis of age or other considerations.

Grazing management. Grazing does not permit of much control over the amount of feed consumed, and if palatable forage is available it is eaten to the full capacity of the individual. If it lacks appeal to the sheep then it is eaten in lesser amounts, and, consequently, the response of the animal is lessened, compared with that obtained when more palatable and equally nutritious feeds are eaten in greater quantity. Because of this fact, the practical feeding of sheep during a large part of the year centers around providing pastures that afford an abundance of feed that is both highly palatable and nutritious. This is not only a sheep management problem but a pasture or range management one as well.

An important practice is to make use of the various forages when they are most nutritious and to provide a succession at various times either by growing several species within the one pasture or by means of two or more pastures. To keep the pastures productive and to retain the most palatable and nutritious plants, grazing must not be so severe as to result in damage to the plants. Almost all plants, with the possible exception of bluegrass or similar

species, will die if severely or excessively grazed continuously. Hence, one of the best pasture practices is to allow periods for plant recovery by changing pastures from time to time. This the rangeman accomplishes by the movement of his flock. The farm producer may accomplish it by dividing his fields and grazing different areas during alternate periods or by providing different pastures for use at various times. Some grazing studies indicate the practice of either moderate or heavy grazing at alternate periods is one of the best means for retaining pasture productivity and securing the largest production of lambs and wool per acre. Grazing can be deferred during some years to permit some plants to produce seeds; reseeding is sometimes advisable. Either stocking so heavily that a pasture is overgrazed or stocking so lightly that it is undergrazed may be detrimental to the pasture, and neither of these may give the maximum return. Because the carrying capacity is so closely related to climatic conditions and because adjustments in animal numbers often cannot be readily made, management to meet any set of rules to avoid overgrazing or undergrazing is extremely difficult. How this may be accomplished is the basis of many discussions regarding range and pasture management. The safest procedure is to try to have a moderate rate of stocking. This will mean heavy stocking during poor seasons and light stocking during the good. Ideal methods would likely be the reverse of this, but our present knowledge does not enable such advanced planning. The producer must try to make optimum use of the forage to get the maximum product without detriment to future use and productiveness. As Sampson [1] points out, findings that are true with some plants in some areas may not be applicable in other cases.

For many years it was urged that the main reason for rotating sheep on pastures at relatively short intervals was that this was one of the best means of controlling internal parasites. But this has been shown not to be a thoroughly effective means of parasite control. Benefits to the pasture and greater gains are two of the main advantages of pasture rotation.

It is poor practice to remove sheep from a pasture during most of the day and allow them only short grazing periods. Much labor is involved, and the sheep are too frequently disturbed. The natural time for sheep to graze is early in the morning and late in the afternoon. With the necessities of salt and water provided on good

[1] A. W. Sampson. Range and Pasture Management. John Wiley and Sons. 1923.

pastures or range, it is an axiom for best results that sheep should be disturbed, driven, or handled as little as possible. Under range conditions the sheep are in charge of the herder who gives the attention needed. Under farm conditions a daily inspection will suffice.

Shade. Most sheepmen like to have shade available during the summer for the comfort of the flock while it is resting. Sheep seek shade in which to bed down. Whether or not shade is an absolute essential may be debatable, but thoughtful flockmasters like to see the flock resting in maximum comfort. Trees are the best shade, but it is possible to provide portable or other types of shade in pastures if there are no trees.

Everyone who raises sheep should have a thoroughly practical way of watering them. Fresh, cool water is preferred by sheep, and, whether on pastures or in the feed lot, they should have water available in reasonable distance. On the best ranges all areas are within a short drive of a stream or water hole. In winter on many ranges, snow is eaten and is the source of water for sheep.

FEEDING BREEDING SHEEP

It is possible to treat the subject of feeding in several different ways, as the year is divided into various rather distinct periods. The flock year generally begins with the breeding season. This is followed with the period of gestation or pregnancy. The lambing period involves certain distinct angles or problems of feeding. The time when the lambs are nursing and their feeding for market after weaning, if not of satisfactory weight and condition, extends over several months in each case. The year is completed with the period when the ewes are dry and prepared for the next breeding period.

FEEDING RAMS AND EWES DURING THE BREEDING SEASON

The vast majority of ewes are fed on pastures during the breeding season, since this season extends from summer through the fall and early winter. In some parts of the country ewes are bred in the summer to drop their lambs in November and December. Elsewhere, the breeding season may be at later periods because of the influence of weather conditions and other considerations. Regardless of the section of the country, pasture feeding is the rule.

Courtesy University of Illinois

Flushing may be accomplished on good pasture.

Most producers endeavor to have the ewes in a gaining condition at the time they are bred. This is brought about through the use of the best pastures or may be induced through the use of a small amount of grain if pastures are not satisfactory.

Flushing. The practice of feeding the ewes well so they gain in weight prior to and during the breeding season is called "flushing." Ewes may be flushed quite as well on pasture as by any other feeding practice. Some breeders reserve some pastures or parts of the range for this purpose. There is some information to the effect that if twin lambs are wanted the ewes should gain at least seven pounds per head during the flushing season of several weeks. On the other hand, some research work indicates twinning is not influenced by feeding but is largely fortuitous. It is unlikely that all of the benefits that are ascribed to flushing will be realized. Some of the benefits are said to be earlier breeding, breeding more nearly at the same time, and the production of more and better lambs. Even if these things are not all accomplished, it is difficult to see how the practice of flushing would be detrimental in attempting to attain them.

It is commonly observed that most of the twins are produced mainly in the early part of the lambing season. In some cases as many as 78 per cent of the twins were dropped during the first

half of the lambing period. This may indicate that the best nourished ewes come in heat first and that they are most likely to shed two ova and to conceive, or it may mean that feed and pastures are better early in the season and thus have some effect on the number of ova available for fertilization. The United States Department of Agriculture reported an increase of 18 per cent in the number of lambs when ewes were flushed. Many practical breeders ascribe even larger percentage increases to the practice. However, there are times when there are no significant increases. In such cases the practical man ascribes the difficulty to the ram. The nutrition of the ram at this time is important, but there is no great support from the field of science that some rams are responsible for more twins than others, if a high state of fertility exists in both cases.

Since body temperatures may be related to the fertility of the ram, feeding may have some relation to his fertility. There is no report that shows flushing of the rams is of much moment. But rams should be well fed during the breeding season. Where many rams are turned with a large number of ewes, as under range conditions, the rams will become thin during the breeding season. Under farm conditions the ram is sometimes removed from the flock for a short time each day and given extra feed to keep him in good flesh. A pound daily of any usual grain ration will be apt to prove satisfactory.

Whether it is better to have the ewes in a good state of condition at all times or to allow them to become somewhat thin and then recondition them has not been determined in relation to the effect on the lamb crop. Neither has it been established which if any of the dietary essentials such as proteins, minerals, vitamins, or energy is mainly responsible for any increased lambing percentages. It has been reported from California that vitamin A may become depleted to such an extent that it may be an important factor in lamb mortality. Also, low protein and low phosphorus intake may be a factor in the percentage lamb crop. Since a reasonably good condition is indicative of nutritional adequacy in the feeding program, it is sound procedure to resort to flushing to assure optimum nutrition during and subsequent to the breeding season if the ewes are not already in good condition. When natural grazing does not seem to provide such nutrition, the use of supplementary feeding is advised. Under most conditions a half to three-quarters pound of grain (oats, oats and corn, or one of these grains

and a quarter pound of protein concentrate) should be an adequate amount for the breeding season.

Some practical sheepmen advise against the use of succulent pasture at this time, as it is their belief that ewes will not get with lamb readily on such pastures. However, there are others whose records show large lambing percentages following the use of such feeds as growing legumes during the breeding season. There is apparently nothing in such feeds, from the standpoint of nutrition, that should make their use detrimental.

Feeding sheep so that they become overly fat at any time is certainly a mistake from the standpoint of economy. There are instances where show sheep in high condition have bred satisfactorily, but such cases do not constitute a recommendation for a practice which is essentially wasteful. Highly prized individuals that are very fat should be reduced in condition for breeding.

FEEDING AND MANAGEMENT DURING PREGNANCY

Gestation period. The gestation period, the time between mating and the delivery of the young, varies to some extent with breeds and with individual ewes. The following data[1] illustrate this variation in ewes of medium-wool type.

TABLE 25

THE GESTATION PERIODS OF 764 EWES

Number of days	140	141	142	143	144	145	146	147	148
Number of ewes	1	0	11	16	45	104	149	136	105
Percentage lambing	0.13	0	1.4	2.1	5.9	13.6	19.5	17.8	13.7
Number of days	149	150	151	152	153	154	155	156	
Number of ewes	89	44	30	13	13	5	2	1	
Percentage lambing	11.6	5.8	3.9	1.7	1.7	0.65	0.26	0.13	

The average gestation period for the ewes in the above table is 147 days, although the greatest number lambed at 146 days after mating. More than 75 per cent of them dropped their lambs between 145 and 149 days after breeding. The gestation periods for 2,500 range ewes varied from 141 to 159 days.[2] There was a slight increase in the length of the period with advancing age, and some breed differences were noted. It is a common observation that

[1] Wis. Agr. Exp. Sta. 19th & 24th An. Rpts.
[2] Jour. Animal Sci. Vol. 3, No. 4.

Rambouillet and Merino ewes carry their lambs for a slightly longer time than the medium-wool breeds. This is shown by records pertaining to 338 Merino ewes. Most of them lambed on the 149th day and 86.6 per cent in the period from the 147th to 152nd days. Figures do not bear out the opinion that males are carried for a longer time than females. Of course, if twins, a ram and a ewe lamb, were born, they would be carried by the ewe for the same time. Very likely some of the variation in the time is due to the variation in the time of ovulation and also to the differences in the time at which fertilization of the egg cells occurs, although there is surely some variation in the onset of delivery labor in relation to fertilization.

Shelter. Shelter and protection are often necessary during a part or all of the period, although this varies much with the locality. While strong, healthy ewes can withstand considerable severe weather, it is nevertheless advisable to protect them during many periods of stormy and very cold weather. Providing a reasonable degree of protection is a part of good husbandry. During mild, dry weather the ewes may be allowed to bed out-of-doors, but on many days and nights a dry and well-bedded shed not only adds to the comfort of the flock but facilitates feeding and caring for it. It seems likely that ewes near lambing may suffer injury to their udders if they lie on very cold ground. About 15 square feet of floor space per ewe is generally ample. Close housing without provision for good ventilation is not conducive to good health. Strong drafts, through openings in the shelter, that blow directly on the ewes is a frequent cause of colds. Protection and clean quarters are also helpful in keeping the fleeces clean and in good condition. Rain is usually much more harmful to ewes than snow, as they often lie down in snow and can shake from their fleeces that falling on them. Good shelters may be open on the south side. If enclosed, openings should be wide to avoid crowding when entering or leaving.

Exercise. Exercise is not a special problem at any other season of the year, for, when grazing, sheep exercise as they gather their feed. Many sheep raisers apparently overstress the need of a large amount of exercise, as ewes have on many occasions come through this period in excellent health and condition when confined to relatively small areas. The most satisfactory way to provide exercise is to let the flock have access to pastures that have been

Courtesy University of Illinois

Waste feeds are suitable for early pregnancy.

reserved for winter use. They should not, in most sections outside of the range areas, be compelled to gather all of their feed, but they may gather some of it from fields of bluegrass, rye, wheat, or even stalk fields. To make them live entirely on dried field feeds in the humid sections is inadvisable, as much of the nutrient value may have been leached from the plants. If their minimum needs are provided for by giving them harvested feeds, the daily exercise obtained in field feeding stimulates their appetites and seems to aid in keeping their digestive and muscular systems in good condition.

Often ewes are inclined not to exercise when lambing time is near. Some experienced shepherds recommend that they be driven for at least half a mile daily at a leisurely gait, and others suggest that a part of their feed be given some distance from the fold so they will be compelled to walk to get it. Some have successful lambing seasons without resorting to these practices. Certainly, exercise may be overdone, and excessive exercise may be harmful. Most caretakers agree that ewes should not at this time of the year be driven through mud or chased by dogs. Ewes that are very heavy with lamb are better off without exercise to any great extent.

Water. The caretaker will need to give special attention to some items. Water is an essential of good care and management, and it should be provided in abundance and at suitable temperatures if possible. Water that is very close to freezing temperatures is not considered good for sheep near lambing; it is often used, but it is not drunk in large amounts. A ewe will drink from two to

four quarts of water daily, even in cold weather if on dry feed. The use of succulent feeds, silage, and roots reduces the water that is drunk. In some areas sheep depend on snow for rather extended periods, but this does not mean that snow is preferable to water for them. In other sections snow is thought to be very harmful to them if eaten, but this is not true.

Special needs. Many sheep raisers are not awake to the needs of the flock during this period; there are many things which occur that need the attention that is not described by written words but is dictated by the "eye of the master," who is quick to sense and also quick to act. Certainly one should be attentive to keeping the fleeces in good condition. Feet may grow long and require trimming. Mud may dry between the toes and cause some lameness. Wool may cover the eyes and handicap the ewes by making it impossible for them to see. Neither external nor internal parasites should be allowed to infest the animals in great numbers during the winter, for these are an unnecessary hindrance to good performance. External parasites should be destroyed by dipping when the weather is warm, as treating sheep with dry powders for these pests is not very satisfactory, although it may serve to lessen the damage. Some treatments for internal parasites may be administered during the gestation period without danger to the ewes or the unborn lambs. Very likely, many successive heavy infestations of parasites occur because the adult parasites are carried through the winters in the members of the flock.

Feed and lamb weight. That feeding during pregnancy is important may be shown by the fact that the birth weights of lambs may be influenced to some extent by it. There is little difference in the earlier stages of pregnancy between the weights of single and twin foetuses. But in the last half of the period the demand made on the ewe's nutrition becomes more marked in the case of twins, and there is then a weight difference. When ewes that were carrying twins were fed so as to gain 39.5 pounds during the last half of pregnancy, the lambs were 47 per cent heavier than twin lambs from ewes that gained only one pound during the same time. The weight of single lambs may not be similarly affected, for the ewe can more easily supply nutrients for the one.

Many lambs are lost or are severely checked in their development because of insufficient feed for the ewes, especially in the last two months of the period. Extra feed then not only increases the

weight of the lambs but also increases the growth of the udder so more milk is secreted, and hence the lambs grow much faster. In one trial reported by Hammond, twin lambs weighed 67 pounds each at 13 weeks of age when the ewes were well fed compared with only 39 pounds when the ewes were poorly fed the last half of pregnancy.

Increase weight of ewes. Bred ewes should gain from 15 to 30 pounds per head during the five months of pregnancy. This would be true for all ewes that were in reasonable condition at mating, as the lowest of these gains in weight would only offset the increase due to the weights of the lamb or lambs and the surrounding membranes. At lambing time the loss in weight will bring the ewes down to about their weight at breeding. They should be in better flesh at lambing than when bred, for the subsequent lactation or nursing period is much harder on them than the gestation season. Hence, they should enter the nursing period with some reserve flesh if possible. However, the character of the feeding which they receive during this period may be of more consequence than a mere increase in weight. Ewes during this period are maintaining their bodies, developing the foetus, growing a fleece, and should also store up some reserve of fat. When so nourished, they are apt to give birth to strong, vigorous lambs and to have a good supply of milk to give the lambs a good start toward rapid growth and development. A good supply of milk at lambing time is one of the best assurances against having disowned lambs. The matter of thrift and ability to make good use of feed at this time is so important that it is unwise to try to succeed by maintaining a flock of thin, poorly nourished ewes.

A good many flock owners believe their ewes are doing well during this period when in reality they only appear to be doing so because of the growth of wool.

Pasture and range. Wherever possible, pastures should be relied on to supply most if not all of the feed during the first three or four months after breeding or for the entire time of gestation. There is no better way of feeding, for in this way ewes gather their own feed without the expense of harvesting, storing, and handling; and while they are thus saving the owner expense, they are getting exercise which aids in keeping them strong.

On the ranges, ewes during this time are maintained on the winter grazing areas. When these sections do not supply sufficient

grazing, supplementary feeds are used. The character of the winter range varies greatly. In some places it is about the same as the summer range but at a lower altitude, and the vegetation is more mature; in others, winter ranges are largely of the brush or browse type. In some large areas of fenced range, the same lands may be grazed throughout the year with such supplementary feeding as needed. Supplementary feeds for use on the range usually consist of hays, preferably alfalfa or other legume hay, grass hays, or concentrates. Often, protein concentrates in the form of pellets or cubes are used, for these may be scattered about the feeding grounds and are not blown away nor difficult for the sheep to find. These legume hays and the concentrates are among the best of the supplementary feeds, as they assure adequate proteins and increase the minerals eaten. Some of the range plants contain surprisingly high amounts of proteins even after reaching maturity. In the drier areas there is little loss of nutrients through leaching. Heavy snowfall is one of the major handicaps to grazing on some of the northern ranges.

Outside of the range areas, where sheep raising is important, pastures may be used for much of the winter except in the extreme northern states. Even in these some grazing is possible during many winters. Feeds in grain stubble fields, cornstalks, permanent pastures such as bluegrass and redtop, and growing fields of winter wheat, rye, barley, and oats are used throughout these regions. Stalk fields are best early in the season, for they deteriorate rapidly through the loss of leaves by the winds and leaching from the rains. Fields in which there are many burrs that cling to the fleeces are best avoided because of the reduced wool value such burrs cause. Many fields of small grains make excellent pasture, and there are areas where grazing them to a reasonable degree will not result in a reduced yield of grain when pasturing is discontinued at the proper time in the spring. Heavy pasturing will reduce grain yields. Permanent grass pastures are valuable at this time, but since they are not in an active growing stage during the winter and much of the plant food material has been transferred to the root systems, they are not so nutritious as when growing. There is not great danger of injury to the pastures at this season if the ground is firm so erosion hazards are eliminated.

Roughages. Harvested roughages will be necessary for many flocks during winter. Many different kinds of hay are fed, but none

surpass the legumes. Mixed hays are useful too. It is difficult to get as good results with grass hays even when supplemented with additional protein as from legumes.

Hay may be fed in various forms, but most is fed long or uncut. Since sheep naturally have two grazing periods a day, it is good practice to feed the ration in two approximately equal feedings daily. A common practice, when both grain and roughage are fed, is to put both in the rack at the same time before the sheep are allowed to eat. However, this depends upon the type of equipment used, and the two types of feeds may be fed separately. The feeder should be sure that there is ample rack space so all may eat without crowding. For average-sized ewes fed entirely on harvested feeds, a daily hay allowance of three to four pounds is ample.

If there are no other provisions for the ewes to exercise, some of the roughage may be fed on the ground or in racks some distance from their quarters. Corn fodder or stover is often fed in this manner.

Silage has been fed to bred ewes for a number of years, but earlier reports did not indicate that it gave good results when fed in large amounts, and it was usual to suggest that the amount fed be limited to about three pounds daily. However, there is no harm whatever in feeding good silage as the only roughage to bred ewes throughout the pregnancy period. Silage made from nonleguminous plants, like hays from the same types of plants, is lacking in protein and in calcium. When these deficiencies are corrected through the use of suitable supplements, silage is a very good feed and may be the only roughage fed. Under most farm conditions both hay and silage could be fed, and a legume hay with corn silage would have some advantages over hay alone. It might be cheaper, and it would provide greater variety. Silage is also a fine source of succulence. It is convenient to feed, is free of dust, and there is no chaff to work into the wool. If used as the exclusive roughage of the ration, the needed protein can be supplied by a daily allowance of a fifth to a quarter pound of protein concentrate; one-half ounce of feeding-grade limestone or similar material will provide the extra calcium. These amounts may be readily provided and the salt requirement, too, by scattering on the silage a mixture of 800 pounds of soybean oil meal, 100 pounds of limestone, and 100 pounds of salt fed at the rate of one pound daily to each four or five ewes in the flock.

Courtesy Grazing Service

Good feeding during the latter part of the gestation period is particularly important.

Grain in winter. For ewes that are to lamb early—that is, during the winter months—some grain feed is advisable for the last month or six weeks of the gestation period. There are several reasons for this recommendation. One of the most important is the reduced capacity of the ewe to consume large amounts of bulky feeds because of the rapid growth of the foetus during the last two months of pregnancy. Especially in the case of twin lambs is there a very great decrease in such capacity, for the lambs and the membranes occupy a large portion of the abdominal region. This is the time when the need for nutrients is great, and in order to have a fully adequate supply, the ration should be more concentrated. The usual admonition that the amount of feed should be reduced with the approach of lambing is therefore automatically taken care of. Ewes that will eat as much as seven or eight pounds of silage daily during the first three or four months of pregnancy will not eat more than four or five pounds later. To give the ewe

sufficient nutrients to maintain all of the metabolic processes, highly nourishing feeds are needed. The exact time to begin feeding concentrates will vary, but it is a safe rule to do so about a month or more before the first lambs are due in the flock. Some saving of grain can be made by sorting the early from the later lambing ewes.

Various grains are entirely satisfactory. The grain or grains selected will depend upon availability, prices, and upon the kind of roughages fed. When legume hays are used corn is a good grain, as it is highly digestible and supplies the carbohydrates and energy needed. When roughages other than legumes are fed, grain rations with a higher protein content than that of corn should be used. The nutrient content of the ration rather than the use of specific feeds is the goal. Hence, single grains or various mixtures may be used. Most practical sheepmen consider oats as one of the best feeds. Some of them criticize corn very severely, but this criticism arises from misuse rather than because corn is harmful to either the ewes or their lambs. Some claim that corn results in the production of too much heat and that it will cause sheep to lose the wool. Experience in recent years has, however, thoroughly discredited this criticism.

Paralysis and feeding. Troubles during the latter part of the gestation period may be due largely to improper feeding. Lambing paralysis or pregnancy disease (*see* Chapter 40) is now considered to be controllable through proper feeding. It is due to disturbed metabolism, which is related to the intake of inadequate amounts of carbohydrates. While the use of corn will not eliminate all cases of the difficulty, it does provide a good source of such nutrients needed at this period.

Economy. The owner must think of economy and efficiency in feeding. Usually a half to three-quarters of a pound of grain daily per ewe will be sufficient, although very large ewes, or those that have been on scant feed previously, will need more. In general, one pound of grain to six pounds of dry roughage is a satisfactory proportion for feeding at this time. Table 26 on page 303 shows examples of rations that have proved satisfactory for bred ewes. The amounts given are for ewes that weigh from 125 to 150 pounds.

If none of the roughage is legume, then the amounts of meal should be increased to provide an ample quantity of protein. Any of the common protein meals may be used.

TABLE 26

SAMPLE RATIONS FOR BRED EWES

Examples of Rations for Bred Ewes before Grain Feeding Is Begun
(All figures are in pounds per day)

a)
1.5 to 2.0 ....alfalfa hay or other legume hay
4.0 to 5.0 ....corn or sorghum silage
b)
2.0 to 2.5 ....alfalfa hay or other legume hay
1.5 to 2.0 ....prairie hay, straw, or similar feed
c)
6.0 to 8.0 ....corn or other nonlegume silage
0.2 to 0.25 ....protein concentrate
0.02 to 0.03 ....calcium supplement

When grain is being fed, the following may be used at the rate of 0.5 to 0.75 pound daily for ewes weighing about 125 pounds. For heavier ewes increase the grain 0.10 pound for each 10 pounds increase in weight of the ewes.

d)
50 lbs....................oats
30 lbs....................corn
10 lbs....................bran
10 lbs....................meal

If the ewes are thin the mixture may be

e)
30 lbs....................oats
50 lbs....................corn
10 lbs....................bran
10 lbs....................meal
f)
80 lbs....................corn
20 lbs....................meal
g)
50 lbs....................oats
50 lbs....................corn

This is an important time to avoid mineral deficiencies. Good rations will provide sufficient amounts in most localities. If extra minerals are needed, simple mixtures will supply the needs at much less cost than complex ones.

From the discussion in the chapter on nutrition, it is apparent that salt and water should be provided in liberal amounts at this as well as at all other periods.

THE LAMBING PERIOD

To raise and market, or add to the flock, every lamb born should be the aim of the sheep raiser. This is not often attained, but the nearer one comes to its accomplishment the greater is his success and the larger his income. Certainly, it is folly to feed and

care well for ewes so that they may drop good, vigorous lambs and then neglect to do all that can be done to save the lambs after they are born. Yet the loss at and soon after lambing is often the largest of the losses sustained during the entire year. Death of lambs to the extent of 15 to 30 per cent of the number dropped is not uncommon. Losses of the latter figure or more are really disastrous. One can hardly admit lambing time has been successful if more than 10 or 15 per cent of the lambs are lost. These percentages will seem high to some producers, yet few will find the losses in their flocks to be less. Occasionally, losses will not exceed 5 per cent.

The attainment of the above objective is made easier by realizing the importance of neglect; by properly preparing for the lambs; and by giving sensible attention to the ewes before they lamb, during lambing, and to both the ewes and the lambs afterwards. Trusting to luck is poor preparation for lambing and a poorer precaution during and following it.

Use lambing pens. Preparation will not be the same in all sections, nor need it be the same at all times in one section. If lambs are to be dropped in cold weather, then extra attention must be given to the matter of protection. Except during very cold times lambs may be saved even if they are born in quarters that are not artificially warmed, but facilities for warming the quarters may be added assurance that losses will be reduced. Often, a part of the shelter may be partitioned and ample protection given. Another matter relating to the preparation of quarters is the building of lambing pens. These "cells" are said to save many lambs, although some are lost in spite of using them, for ewes may lie on lambs in the pens. But their use is advisable, at least under some conditions. They are best made when two hurdles are hinged together, for then they may be set in the corner of the barn, and each one may make a complete pen if set in a row along the side of the building. The size may be varied, depending upon the size of the ewes, but, usually, the hurdles are 2×3, 3×3, or 4×4 feet. A height of 36 inches is satisfactory. They need not be made of heavy material, and pieces 1×2 inches or 1×3 inches are all right. The openings between strips at the bottoms of the hurdles may be about 3 inches, but those near the top may be larger.

Bedding. Clean bedding materials should be provided when ewes lamb indoors. Straws are probably best, although other things are used. In one very successfully managed large flock, lambs are

dropped on a slatted floor. Heavy one-half-inch mesh wire may be used.

Supplies. Various supplies are often listed by writers as being especially important to have on hand. Certainly there should be some disinfecting or antiseptic materials to be used in trying to avoid infecting the ewe in case assistance is necessary. For the most part, few caretakers have much understanding of real caution at such times. Fortunately, the results which they obtain are not as bad as one might expect. Probably the most important supply is some warm water and soap, for these may be used to clean the hands as well as many clean them with other things. Many shepherds use a combination of an antiseptic and an oil (one ounce carbolic acid and ten ounces olive or mineral oil) on the hands if it is necessary to assist lambing ewes.

Tincture of iodine is used in many flocks. The navel or umbilical cord of each lamb is immersed in tincture of iodine soon after the lambs are born. This is done to avoid troubles that develop later because of infections at this point soon after birth.

A few other materials may be needed from time to time, but there is usually not much need of a big medicine chest filled with "dope."

The prescribing of medicines and their administration to animals has developed to a point where it is of the utmost importance that a correct diagnosis be obtained first, and in many cases it is advisable for the caretaker to have the confirmation of the treatment by a competent veterinarian. Although there are many useful "home remedies" for some of the minor ailments, much medication is ill-advised because the causes of the difficulties are unknown, and many of these require specific measures which may not be available to the layman. In most cases the attendant will find that good care, nursing, protection, and careful feeding are the most effective remedies. There is no exception to the statement that all ailing animals should be separated from the rest of the flock both from the standpoint of their own comfort as well as for the protection of the other members of the flock. Any caretaker who permits weak or diseased animals to be knocked about and trampled is careless, regardless of how skillful he may be otherwise.

A flock of ewes that has been skillfully handled before parturition will demand a minimum of attention during this period.

Help at lambing. When the ewes have been well fed and

have developed well-filled udders, attention at lambing may consist of nothing more than having them in clean, protected quarters and under observation to learn if they can deliver their lambs without assistance. There will be some cases of abnormal presentations requiring aid, but it is as possible to have losses by being too hasty as in being too tardy. Any normal ewe will deliver a normal-sized lamb without help if the lamb is in the proper position. Lambs that are extremely large make it necessary to help the ewe even if the lambs are in the correct position for birth.

As a rule lambs are born with the forefeet and legs extended and appearing first. The head lies between the legs with the nose about halfway between the knees and the elbows. The hind legs extend backwards. Some lambs are born in just the opposite manner; that is, the hind feet and the legs appear first. Although this does not seem to be so favorable as the first position, it is only in the case of large lambs that difficulty is experienced. Sometimes the ribs are broken. Any other position in which the lamb is found may be considered abnormal.

Difficult parturition may then be due to an abnormal position and presentation of the lamb, to the lamb being too large, to a rather undeveloped or abnormal conformation, or to weakness of the ewe.

Assistance that may be given should be based on the following general rules: (1) Cleanliness and careful handling must never be overlooked. (2) Find out what is causing the trouble. Otherwise, damage rather than good is apt to be done. (3) Correct the cause of the difficulty. (4) The ewe will then deliver the lamb or she may be assisted to do so by pulling outward and downward on the lamb as the ewe labors.

Helping lambs. Difficulties may be encountered after the lamb is born. Some may smother, in case the membranes cover the nostrils. Some may be weak and need aid in nursing. Some attention should be given to the udder and teats of the ewe at this time to make certain that the lamb may draw milk and that the ewe has milk for it. Lack of milk is usually due to the fact that the ewe is naturally a very poor milk producer or to the fact that she has been poorly fed. Poor milkers should be culled, as should those that are poor milkers because the udder has been spoiled. If the ewes are sheared about the flanks and udders the nursing of the lambs is facilitated. Indeed, shearing ewes before they lamb is one of the

best practices. The work must be carefully done and all rough handling avoided. Fall shearing is not advised for early-lambing ewes unless heated quarters can be provided in case of extreme cold.

Most publications have considerable discussion about disowned lambs, chilled lambs, and so on. Few ewes disown their lambs if they have a large supply of milk for them. The saving of chilled lambs is possible, but it is just as possible to prevent them from becoming chilled, and the lamb is much more certain to live in the latter case. Chilling is due to neglect and, in the writer's opinion, should be prevented rather than treated. There may be more merit in some methods of reviving a chilled lamb than in other methods, but all of them are based upon warming the body of the lamb and carefully nursing it until it regains its strength. Lambs may be warmed by placing them in warm water, by wrapping in old sacks or blankets, by placing in a lamb brooder, or by covering with an electrically heated pad. Avoid excessive heating, as it is sure death to the lamb.

In all flocks there may be some difficulties with young lambs because of sore eyes. One of the causes is entropion or turned-in eyelids. It is most common in woolly-faced breeds. The tendency is hereditary. To relieve, roll the eyelids outward and hold in the proper position by stitching, or use surgeon's clips or pieces of scotch tape or other adhesive. In very bad cases a small piece of the skin above the eyelashes may have to be removed to effect a cure. Argyrol or other mild antiseptic should be applied to the eyes. Sore eyes may arise from an infection due to the eyes rubbing against dirty locks of wool about the ewe's flanks or udder when the lamb nurses. In such cases remove the cause and treat the lamb's eyes with antiseptics.

Sore mouths are also an affliction of young lambs. This is the same trouble as discussed in Chapter 40.

Constipation is an occasional difficulty with young lambs. Some milk of magnesia, about a tablespoonful, or castor oil, one to two teaspoonfuls, may be given. A type of constipation of real young lambs, called pinning, is caused by feces collecting about the upper part of the tail in a great mass. Treatment consists of washing or scraping this away.

Diarrhea, dysentery, scours, and indigestion may be of different kinds but are generally due to a failure to maintain sanitary

conditions. Some of the newer drugs may be helpful, but there is nothing as good as prevention through the removal of the causes.

Wool balls may be found in the stomach of lambs that have died. These are usually only found in lambs that are raised in barns where some develop an appetite for bits of wool which they pull from old sheep. Once formed, there is no way to remove the ball of wool from the stomach. If there is only a small amount of wool the lamb may "outgrow" it.

Pox-like sores on the teats of ewes may be a real handicap to the lamb. The teats are so sore that the ewe will not allow the lamb to nurse. As a result the lamb does not thrive, and the udder may become caked and spoiled. A sulfa ointment applied to the sores has been used and is more effective than many other treatments.

FEEDING EWES AFTER LAMBING

In general, the feeding of ewes after they have lambed may proceed on the same basis as before except that the ration should be increased in quantity, as the ewe's capacity for feed and her need for it have both increased. It requires very liberal feeding indeed to maintain the condition of heavy-milking ewes. It is doubtful if it is necessary to maintain the ewe's weight, although on good pasture or range ewes may yield large amounts of milk and still remain in good flesh. Any loss of flesh during the suckling period is readily regained by ewes after the weaning of the lambs. Ewes that are easy to keep in high flesh after they have lambed are generally poor milk producers, a condition that is readily noticed by the relatively poor growth of their lambs.

Two suggestions are usually made regarding the feeding of ewes. Grain should be fed sparingly for a few days after the ewes lamb. It is also a good plan to separate the ewes with twins from those with singles and feed the former more grain than those with singles. In fact, some large lamb producers find this practice so advisable that it is followed regularly, and the bands are separated on this basis even when on pastures.

Since milk production is greater on rations that contain some succulent feeds, an effort should be made to supply something of that kind. During winter, silage is the most extensive source of succulence. Any suckling ewes that are fed on legume hay, silage, and a reasonable grain allowance will very probably be well nourished. Two or two and one-half pounds of hay plus all the silage

the ewe will eat and one pound of grain will be adequate until most flocks can be turned to pasture. In the light of present information, it is advisable that pastures be provided at as early a date as possible. In most sections where farm flocks are kept, the use of cereals for pastures is the most helpful practice in this effort. The use of such pastures saves harvested feeds, stimulates milk flow, and increases the growth of the lambs. Because of weather conditions such pastures are not always easy to use, and there may be times when recourse to harvested feeds will be advisable.

As soon as the spring range or pasture season has arrived, the use of harvested feeds for the ewes should be discontinued. It is uneconomical to grain-feed ewes on pastures, and it is indeed unnecessary. While grain is fed to many purebred ewe flocks on pasture, the practice is of doubtful value to an industry whose foundation is the ability to make the most efficient use of pastures.

For dry-lot feeding before pastures are ready in the spring, the rations previously given will be suitable for use in the localities where the ingredients are available. The proportion of grain to roughage should be about one to three rather than one to six as recommended for the latter part of the pregnancy period. Hence, the amount of grain fed at this time will be about one pound for ewes that weigh 125 pounds.

FEEDING GROWING LAMBS

The prevention of disease and the promotion of growth of the lambs mark the success of the period between lambing and the sale of the lambs. Lambs cannot grow well unless they remain healthy and are given an abundance of nourishment. Interruptions in the growth of lambs are costly, and, hence, one should do those things which serve as protection to the health of the lambs. The careful sheep raiser makes constant efforts to avoid anything that would handicap the lambs. He knows that lambs that do well are the profitable ones.

The most important feed for young lambs is milk. During the first two weeks of the lamb's life its only feed is milk, but after that time it begins to ingest other materials and continues on both milk and such other feeds as provided or available for a period of four to six months. By weaning time milk has become so reduced in importance that the lamb can rely entirely on other feeds.

The lamb-raising abilities of ewes is closely related to their

abilities to produce milk. Some lamb raisers have stated that their ewes were such heavy milk producers that the lambs were unable to take all of it, and that the lambs developed digestive troubles and scouring. That such cases do exist is possible, but it is much easier to remove some excess milk from the udder for a few days than it is to try to raise lambs when there is too little or no milk for them, and the ewe is rare indeed that will long have too much milk for a vigorous pair of twins or even a fast-growing single lamb.

Colostrum. The survival of lambs is closely related to their prenatal development and to their size, strength, and vigor at birth. Their survival is also closely related to the colostrum or first milk of their mothers. Colostrum differs markedly in chemical composition and biological properties from the milk yielded a few days after the birth of the lamb. Colostrum may be as much as 100 times richer than later milk in vitamin A. Its protein is more largely in the form of globulins, which are identical with the globulins found in the blood of the lamb. Further, colostrum is apparently very rich in certain antibodies which may have great protective properties against miscellaneous bacteria. It seems reasonable to conclude that colostrum causes certain reactions in the body of the lamb that are less likely to occur if the lamb is deprived of it. These reactions relate to the resistance of the lamb to certain infections and to the absorption and assimilation of nutrient materials. It is therefore extremely important that lambs receive the first milk of their dams and that the use of "foreign" milk in the feeding of orphans be delayed for several days if possible.

Milk yield and composition. At birth the fourth section, the abomasum, is the largest of the sections of the stomach. It is to this part that milk passes directly, and it is here too that the digestive juices are active. After a short time the other sections of the stomach grow rapidly, and the rumen, or paunch, soon becomes the largest section. Because of this the lamb is able to place increasing dependence upon feeds other than milk, although it continues to benefit from milk for several months. Studies show that the amount of milk the ewes yield is of more importance in the growth of lambs than is the quality of milk. The yield of milk by sheep will probably vary from 100 to 300 pounds during a four- to six-months period. On a daily basis the yield may range from less than two pounds to more than seven. In the production of milk, ewes compared very favorably with cattle with respect to the feed intake per

Courtesy University of Illinois

Sturdy, fast-growing lambs are obtained when their dams provide a good supply of milk.

100 pounds of milk. One hundred pounds of milk were produced for 113 pounds of dry matter consumed by ewes.[1] Since the ewes were also growing a fleece of high protein content and since they yielded milk of a higher fat content, they may be considered as comparing favorably with cows in economy.

Lambs from heavy-milking ewes have gained 79 per cent more during the nursing period than lambs from poor-milking ewes. With a liberal supply of milk, vigorous, strong lambs will double their birth weights in two weeks and, thereafter, with liberal feeding will gain from 0.5 to 1.0 pound or more daily for several months' time. Many lambs make 50 per cent of their first year's gain during the first three months of their lives, hence the great importance of good feeding at that period.

TABLE 27

PERCENTAGE COMPOSITION OF EWE'S AND OF COW'S MILK

	Dry matter	Digestible protein	Fat	Nitrogen-free extract	Total digestible nutrients	Calcium	Phosphorus
Ewe	19.2	6.1	6.9	4.9	26.0	0.21	0.12
Cow	12.8	3.3	3.7	4.9	16.2	0.12	0.09

[1] SHEPPERD, J. H. Agr. Sci. Vol. VI.

The average composition of milk from cows and ewes is shown above. There is a wide range in percentages from these average values, as the fat content of ewe's milk may range from about 2 to 12 per cent. Compared with cow's milk, that of sheep is richer in protein, fat, calcium, and phosphorus. The nitrogen-free extract is mainly sugar. These relative compositions are important in the feeding of orphan lambs. There have been recommendations that cow's milk should be diluted when used for lambs, but since it is not so rich as ewe's milk, this of course should not be done.

Orphan lambs. Efforts should be made to "graft" orphan lambs on other ewes that have lost their lambs or that have single lambs and are good milk producers. Various methods are suggested to aid in accomplishing this. In some cases none of the methods will be successful, as a ewe will not adopt another's lamb. A common method on the range is to remove the skin from a dead lamb and place it on the orphan for a few days while attempting to get the ewe to adopt it as a replacement for her own lamb. The reason for this method is that ewes recognize their lambs by smell. The pelt should not be left on for more than two or three days. Other methods consist of rubbing some milk, oil, or kerosene on the ewe's nose and on the rump of the orphan. Some adoptions are made by tying the ewe and placing the lamb in a small pen with her. Sometimes the presence of a dog may encourage adoption. These methods are most likely to work successfully if the ewe and the lamb are separated from other sheep. Some orphans are raised on goats and on cows.

If no foster mother can be found for the orphan, it may be raised by hand by feeding on cow's milk. This is most likely to be successful if the lamb has first had colostrum from its mother or another ewe. The cow milk should be whole, fresh, and warm and be fed from thoroughly clean utensils, and during the first week or two the feedings should be about one or two ounces in amount and at intervals of about three or four hours. Table 28 on page 313 gives a reasonably satisfactory schedule of amounts and times per day. For a few lambs the feeding is best done from a bottle with a medium-sized duck-bill nipple, but for a considerable number the milk may be fed from pans or other containers after the lambs are about two weeks of age. In all cases the most important items are that the milk is given from clean utensils and that these are kept thoroughly cleaned; the temperature of the milk should be about

TABLE 28

Age of lamb	Daily feedings	Amount at each feeding	Daily amount
		ounces	*pints*
1 to 6 days	8 to 6	1 to 2	½ to ¾
1 to 2 weeks	6 to 4	3 to 6	1 to 1½
2 to 3 weeks	4	6 to 8	1½ to 2
3 to 4 weeks	4 to 3	8 to 10	2 to 2½
4 to 6 weeks	3	10 to 16	2½ to 3
6 to 8 weeks	3	16 to 32	3 to 4+

90 to 100 degrees Fahrenheit. After the lambs are two weeks of age, they should be given dry feed or pasture in addition to the milk.

Creep feeding. Lambs that are born early in the year in those sections where good pastures are not available at that time should have a place provided for them where they may eat apart from the ewes. Such facilities are called "creeps" and are made by using hurdles with openings that allow the lambs to pass through but keep the ewes from doing so. Within the creeps the lambs find feed that is especially prepared and particularly suitable for them. The openings in the hurdles should be about 8 inches wide, although with some of the larger ewes and lambs they may be 10 inches. Usually, the height of the openings is from 15 to 18 inches, although this, like the width, is sometimes made adjustable so that changes may be made from time to time as the lambs increase in size. When the height of opening is adjustable, the ewes may be more easily kept out of the creep.

As is the case with ewes, many different feeds and feeds in different combinations are used for young lambs. One of the best mixtures used for the lambs at the University of Illinois has been made of 20 pounds of whole or crushed oats; 20 pounds of cracked corn, 10 pounds of wheat bran; and 10 pounds of linseed, soybean, or cottonseed meals. However, good results may be obtained with other feeds or with only some of the feeds suggested in this mixture. Some very good lambs have been raised on only oats and corn and some on only one of these. When possible to feed a greater variety, without too much added cost, this is recommended. For lambs to be marketed, the oats and bran may be reduced gradually and corn increased when the lambs are about three months of age.

Little lambs, like older sheep, need bulk in the rations, and this should be provided either by using some cut hay with the grain

Courtesy R. F. Miller, University of California

Creep feeding of lambs is advisable except under very good pasture conditions. Creeps should permit lambs easy access.

or else hay should be fed separately. If the choicest alfalfa hay is cut and mixed with the grain, a safe and nutritious ration can be made by using roughage to the extent of one-third to one-half of the ration. If the mixture suggested above is to be used, it will generally be satisfactory to add 20 pounds of cut alfalfa to the 60 pounds of concentrates, as the bran and oats are somewhat bulky. However, if only corn and a legume hay are used in this way, it is recommended that 50 pounds of the cut hay be mixed with 50 pounds of corn. Lambs may then be allowed to eat all they will of these rations.

In fact, the rations may be self-fed if one wishes to do so. For small flocks, fairly satisfactory feeders may be made from barrels. About 12 to 15 lambs can eat around one such feeder.

Whatever method of feeding is followed, the feed should be kept clean and fresh, as lambs do not eat so much and therefore do not do as well if the feed is damaged in any way or if they have large amounts in the feed containers at one time and "work over" it. The

cleanliness of the quarters and the comfort of the lambs are important in creep feeding. While young lambs eat only small amounts of feeds, these quantities are important in promoting growth and fattening. At this time the gain in weight is made on small amounts of feeds. Nursing lambs under three months of age may make 100 pounds of gain on 125 to 150 pounds of grain and 100 to 125 pounds of roughage in addition to the milk of the ewes. After the lambs are old enough to wean, from three to four or more times these amounts are required.

Pastures for lambs. Lambs are unique among farm animals, as they may be marketed at top prices off grass. While many other animals are sold off grass without having had any other feed, lambs are the only group that may bring top prices. Hence, it is worth while to make an effort to learn the essentials regarding the feeding of lambs on pastures.

Good pastures for lambs are those that are rather succulent and that are composed of plants that are palatable and nutritious. Pastures are most nutritious when they are in an active growing condition, and it is only from such pastures that top fat lambs are obtained. When pastures lose their succulence, the lambs lose the "sappy" condition and become thin and "woody." When there is likelihood that the pastures will not remain good, and therefore keep the lambs growing fast and in good condition, creep feeding should be used on pasture. This would usually be the case when bluegrass or similar pasture had to be used throughout the summer. This grass will not stay succulent, and many lambs that are fat during the early season lose their condition and sell at a discount. Creep feeding is assurance that this is not so likely to happen. For this purpose the mixtures of concentrates that were suggested for use in creep feeding before pastures are ready may be used.

It is likely that creep feeding is not necessary or economical under other conditions when lambs are on pasture. In most cases suckling lambs on very good pasture seem to be satisfied with their mother's milk and the pasture, and they will eat only small amounts of feed. Indeed, in some tests the amounts were so small as to be of no importance and far from sufficient to justify the work involved in following the practice of creep feeding on pastures. This means that the sheep raiser, wherever he is located, should give considerable attention to his pastures, for these provide the most economical means of raising lambs.

FEEDING EWES AFTER LAMBS ARE WEANED

After the lambs are weaned the ewes are fed on range or pastures, and during this period they should require no feed other than that which grazing affords. If the grazing is reasonable in amount and quality and the ewes are healthy, they will gain in weight and within a month or two will be ready for the ensuing breeding season. This is the period when flushing is practiced and completes the year for the breeding ewes. For all except this short period, the ewes have been passing through the pregnancy or suckling periods.

Rams offer no special problems in feeding, and if they are in good health they should subsist largely on roughages and pastures. A healthy "easy keeping" ram should remain in acceptable condition on good pasture. Rams that require much grain are either "hard feeders" or are unable to make good use of their feed because of some condition which is detrimental to their health. Rams that are being offered for sale are generally fed some grain, but heavy feeding that results in a very fat condition is harmful and uneconomical.

FEEDING WEANED LAMBS

Lambs are frequently ready for market when they have reached weaning age. This should be the aim of the lamb raiser, for if he can have his lambs sufficiently heavy and fat to sell well when they reach this age he is following the most economical feeding practice. Lambs are seldom weaned before they reach 3½ months of age, and many are not weaned until 5 or 6 months old. If they are not ready for market at the latter ages, it is likely that they are not getting much milk and may do better if weaned than if they are allowed to keep on sucking. In a test of this matter a group of unweaned lambs gained 0.23 pound a day; whereas, another similar group weaned gained 0.30 pound per head daily on the same type of pasture.

Weaning is best done by simply removing the lambs from the ewes. For a few days they miss each other but then are no longer concerned by the separation. This is a better procedure than to separate them for a short time and then let them back with the ewes to nurse for a weaning period of a week or two as the periods for separation are extended. Some ewes under the former method may

Courtesy University of Illinois

If lambs are not ready for market at weaning time, the feeding of grain on pasture is a good way to fatten them.

need to be milked once or twice, but most of them will "dry off" without attention.

It is a better practice on farms to creep feed the lambs while they are nursing than to have them in thin condition at weaning. But when they are thin at weaning, the use of grain or good pastures will be necessary to fatten them for market. Not many pastures will fatten lambs. To do so the pastures must be succulent and palatable and partly or wholly legumes. Such pastures as lespedeza, ladino clover, alfalfa, or mixtures are satisfactory, but dry grasses will be disappointing.

For use on pastures a good grain ration may consist of only corn or other grain and some protein concentrate. A mixture of 50 pounds of corn, 40 pounds of oats, and 10 pounds of linseed, soybean, or cottonseed meal will produce good gains. Lambs that weigh 65 to 70 pounds will eat about a pound to one and one-half pounds of grain daily after they have been on feed for three or four weeks. Feeding should start with a daily allowance of one-fourth pound per lamb. If the lambs are not fed on pastures, they will need good roughage to take the place of the pasture. Many farmers feed their lambs in the cornfields after about the first of September. No lambs can respond satisfactorily to feeding if they are unhealthy or

if other good management practices are not used along with the feeding.

For ewe lambs that are to be retained in the flock, no grain will be necessary except perhaps during a portion of the winter. It is usually necessary to feed ram lambs some grain to get a thoroughly satisfactory development, although the amount should not be so liberal as in the case of fattening lambs that must have a high finish to sell well.

The purchase and feeding of lambs is an extensive industry, and special consideration is given to rations for fattening lambs in a following chapter. Feeding practices discussed are suitable for lambs in any section, and judgment will indicate which rations are best under an operator's conditions.

DOCKING AND CASTRATING LAMBS

Wether and ewe lambs are most desired on the markets, and the docking of all lambs and the castration of male lambs intended for market are two important features of management. Docking is the removal of the tail, and castration is the removal or destruction of the functioning of the testicles. It is likely that the actual consumer understands little about these matters and the effect that failure to castrate may have on the carcass or its desirability. In fact, the effect of castration on lamb carcasses and upon rate of growth of lambs is probably less marked than is often supposed.

Castration does not stimulate growth. In fact, it may have the effect of slightly reducing growth, but it does cause a considerable change in the character of growth. The presence of the testicles at an age of four to six months or thereafter tends to develop the so-called secondary sex characteristics, such as a stronger, more masculine head, a fuller, heavier neck, and thicker, rougher, heavier shoulders. Wethers have more of the general appearance of ewes. Since rams are likely to be more restless than wethers, rams may not be so fat at a given time as wethers. Since they may also have a larger percentage of their weight in the less desirable cuts from the forequarters, their carcasses are considered less desirable. However, market men object to ram lambs even though these characteristics are not so noticeable as to be readily detected. The meat from ram lambs may be no less desirable than that of wethers except for the differences in the amount of fat, although this is to some extent a matter of age. After ram lambs are approximately four months of

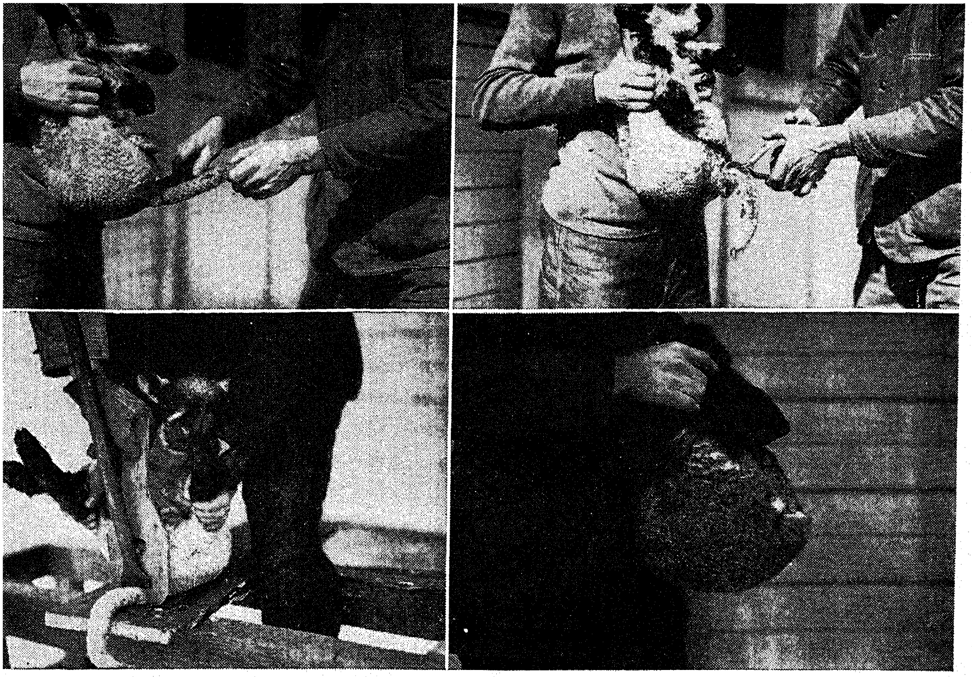
age, it is the general practice to discount them a dollar a hundredweight on most markets. When more than a year old the discount in price, compared with that of wethers, is much greater. Since the market wants docked and castrated wether lambs and docked ewe lambs, it is sensible for the producers to supply them. Ram lambs lacking fat yield lower percentages of carcass than fat wether and ewe lambs. Further, there is practically no outlet for ram lambs as feeders, as the risks in castration at an advanced age are considered too great to make the practice advisable. Feeding ram lambs without castrating them would likewise not often be advisable because the value of the product would be less than for wethers, and the expense of feeding would be equally great or greater. It is largely in farm flocks that caretakers fail to dock and castrate lambs, as the practices are almost universal in range areas.

Docking improves the general appearance of lambs if it is properly done. There are many lambs that are carelessly docked, as the flock will have lambs properly docked and others with stubs of tails from four to eight inches long. The tail serves no useful function and is often a detriment, for long-tailed lambs are even more subject to being fly struck than are docked lambs, and the former are much harder to take care of when they have maggots. Long-tailed ewes are not so readily bred as those that have been docked.

Both docking and castration are best done when lambs are from about 7 to 14 days old, as tissue growth is then very rapid, and healing is promptly accomplished. Both operations may be performed at the same time. In performing this work, sanitation and care are important items in the prevention of losses. A warm day is best. Clean quarters, clean hands, and the use of antiseptics are valuable safeguards if not essentials in avoiding infections. An antiseptic should be applied to all open wounds; in some areas at certain seasons a fly repellent should also be used.

Methods of docking vary from the use of heated instruments that remove the tail by burning to instruments such as knives that are used cold. In some instances tightly stretched rubber bands or strings are placed around the dock and allowed to remain until the tail drops off because of the obstructed blood supply. Similar methods have been used occasionally for castration, but for neither purpose are such methods recommended.

Different types of heated instruments are used, but the effect



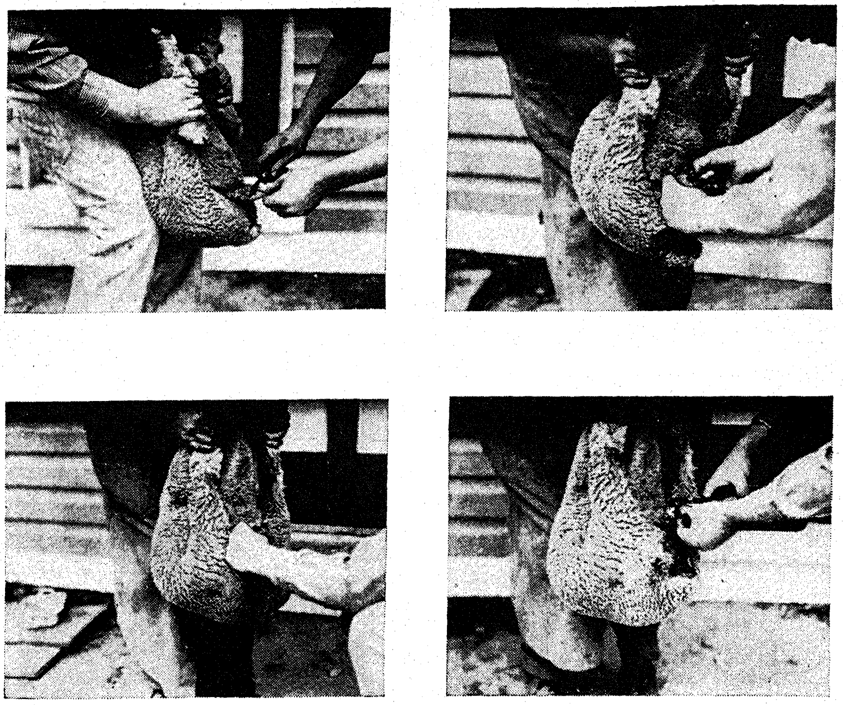
Courtesy University of Illinois

Three tools used for docking are: top left, knife; top right, emasculator; and bottom left, hot iron. Bottom right, the lamb is properly docked.

is the same. In general, these are of a chisel type or in the form of pincers. In using any of them the buttocks of the lamb should be protected by placing the tail in a slot in the end of a board or putting it through a hole in the board. The board, if an inch thick, will serve not only to protect the lamb from the heat but will also measure a suitable length of dock. The advantage in the use of such instruments is in the stoppage of bleeding and in the sterilizing action. Comparisons [1] with respect to rate of healing have shown that the wounds made by heated instruments require a longer time to heal than those made when cold instruments are used. Bleeding may be stopped instantly when cold instruments are used if a heated, pointed rod is touched against the severed artery from which practically all bleeding occurs.

Some instruments that are used cold are designed to crush the tissues and thus reduce or eliminate bleeding; others make sharp, clean cuts that may bleed considerably unless some means of stopping bleeding are employed. In small flocks a string may be tied about the tail before docking. It should be left on for only a few

[1] Texas Agr. Exp. Sta. Bul. 262. 1920.



Courtesy U. S. Department of Agriculture

The three steps in castration are (1) cutting off the end of the scrotum, (2) removing the testicles, and (3) applying antiseptic. Top left, cutting off the end of the scrotum; top right, pulling out the testicles with the adhering cords; bottom left, the testicles are exposed; bottom right, applying an antiseptic.

hours at most. Most lambs that are docked with a knife are not treated to stop bleeding but are turned loose as soon as an antiseptic is applied. A scissors-type emasculator may be used to dock lambs. Since this instrument crushes a part of the tissue as well as cutting off the tail, there is usually very little loss of blood. The Burdizzo-type castration clamp is sometimes used for docking. In such cases it is advisable to cut the tail off inside the clamp after its jaws have been closed. This results in no loss of blood.

Castration is done by either of two methods. In one the testicles are removed while in the other the channels through which they are nourished are destroyed, which causes the testicles to atrophy. The removal of the glands is by far the most common method.

The work is accomplished by cutting off the lower third of the scrotum. The testicles are then exposed and are pulled out together with the surrounding membranes. In doing this the thumb and finger of the left hand are closed back of the testicles so they may be grasped one at a time with the thumb and forefinger of the right hand and withdrawn. If the lambs are more than three weeks old, the cords and membranes should be scraped through with a knife to lessen the loss of blood. Some special devices are sometimes used to pull the glands out. An application of antiseptic to the wound is always advisable. In limited use an ointment of sulfathiazole has given satisfaction. It is possible other sulfa drugs may be equally or more useful. This is a serious operation and may result in the death of the lamb, or it may be followed by an infection if carelessly done.

Special pincers, called Burdizzos or Emasculators, are used in the bloodless castration method in which the testicles are left in the scrotum. There are several advantages to this method, although there are also some objections. There is no danger of infection as no open wound is made; there is no loss of blood, and there is less pain. In a unique test[1] in which twins were castrated by different methods, the rate of growth after bloodless castration was slightly greater than when the knife method was used. A summary of the data is given in Table 29. If the work is not carefully done there

TABLE 29

COMPARISON OF METHODS OF CASTRATION USING TWIN LAMBS

No. of lambs	Method	Ave. initial weight	Ave. final weight	Ave. daily gain during 70 days
26	Burdizzo	37.9	87.0	.70
26	Knife	38.1	84.7	.67

may be some "slips" in which the cords are not crushed, and castration is, therefore, not accomplished. This, however, is entirely a matter under the control of the operator. Another objection is the rather high cost of the instruments. They may be used for a long period, however. Some market men have made objections to this method because of the presence of some "slips" in lambs sold. This is hardly a consistent attitude, for the objection has not been pri-

[1] Scottish Jour. Agr. Vol. 22. No. 2. 1939.

marily upon the presence of the testicles but upon the effects of such presence. If, therefore, the effects are not readily noticeable the objections seem scarcely valid. Since the method is based upon the crushing of the spermatic cord and arteries, the operator must make certain that these are within the jaws of the pincers when it is closed. The speed of operation is not greatly less than with other methods.

CHAPTER 31

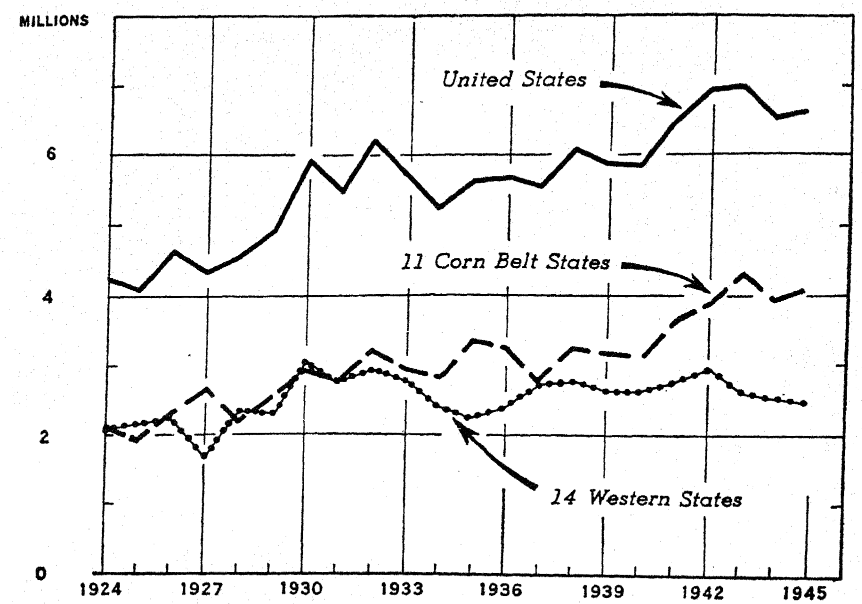
Lamb Feeding

This chapter and the three following pertain particularly to the purchase of lambs for feeding rather than to the keeping of a flock for the production of lambs and wool.

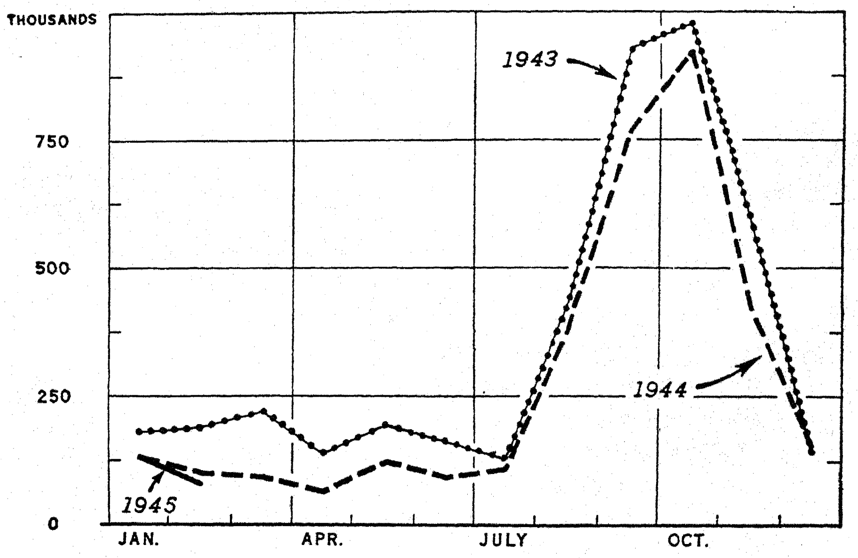
Although much of the plant growth is very nutritious, it is impossible for the range-sheep raiser to have all of his lambs sufficiently large and fat at the time they are removed from the range to yield desirable carcasses. Those lambs which fail to meet slaughter requirements are known as "feeders" or feeding lambs and are sold to men who are equipped to feed them for such lengths of time as are needed to fatten them.

Some sections of the range country have only small percentages of the lambs produced classed as feeders. This is especially true during seasons of ample rainfall. In other sections almost all lambs produced must be sold as feeders because the vegetation is not sufficient to promote rapid growth and fattening. Probably an average of at least 25 per cent of all range lambs sold in any one year are fed for some time after they are removed from the ranges before they are slaughtered. In some years the percentage is considerably higher.

History. The sheep industry is now mostly devoted to the production of lambs, and usually 90 to 95 per cent of the sheep reaching our central markets are under one year of age. Hence, lambs now make up the great bulk of feeders. Formerly, few lambs but many mature sheep were sold for slaughter. Such was the case when the sheep-feeding industry started soon after 1890. Great quantities of flour mill by-products were available about such centers as St. Paul and Minneapolis, Minnesota, and Chicago, Illinois. Some men saw possibilities of profit through the use of these mill by-product materials as feeds for thin sheep. Fed on these products,



DATA FOR 1945 ARE PRELIMINARY



THE 8 CORN BELT STATES ARE OHIO, INDIANA, ILLINOIS, MICHIGAN WISCONSIN, MINNESOTA, IOWA, AND NEBRASKA.

Courtesy U. S. Department of Agriculture

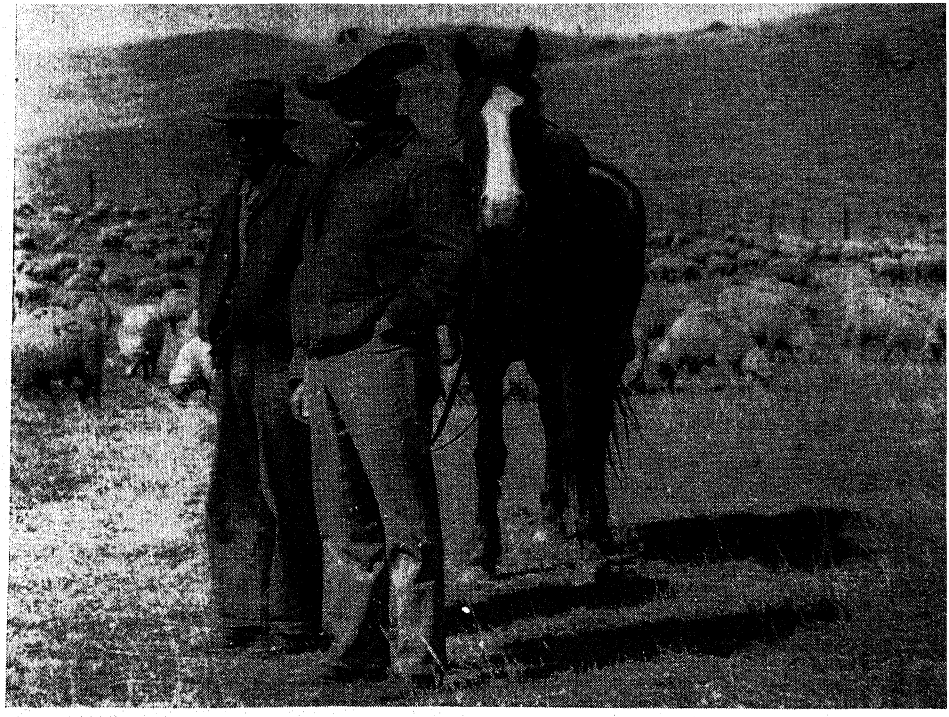
The first graph shows sheep and lambs on feed, January, 1924 to 1945. The second graph shows shipments of feeder sheep and lambs to 8 Corn Belt states, 1943 to 45.

the condition of the sheep was greatly improved, and their suitability for slaughter increased. The building of large yards followed, and soon many thousand sheep from Montana, Idaho, Wyoming, and some other western states were passing through these yards. With little value attached to the feeds and with rangemen willing to sell their sheep at very low prices, profits were large. This was aided by the pronounced suitability of the carcasses of sheep fed on these by-products. The men engaged in the business constructed immense feeding yards and much interest was created. As others became interested, the cost of feeders rose. The by-products of the mills were found useful for other classes of animals and increased in price. Competition developed, and many of the most extensive operators had to close their plants because of the lack of profit and, in some cases, because of heavy financial losses.

Meanwhile, some farmers saw some possibilities in sheep feeding. They grew a large part or all of the feeds needed to fatten sheep, and hence the only cash outlay necessary was for the sheep themselves. Moreover, some farmers saw the possibility of making use of some otherwise unmarketable feeds, and they were quick to see the value of farm weed destruction which sheep or lambs might accomplish when they were fed in the fields. In addition to these things, many farmers assigned a high value to the manure, as it contained a high proportion of the fertilizing elements found in the feeds. Another point which some emphasized was the use of their labor during a greater part of the year.

Although western lambs constitute a very large percentage of the total number fed, native lambs are sometimes purchased for feeding. The former are fed in many sections of the West as well as in the Corn Belt and eastern areas, but natives are generally fed only relatively close to the places where they are raised. This is due mainly to thrift and health considerations, but better methods of husbandry and parasite control may make the native a more popular feeder. However, most farm-lamb raisers usually have sufficient feed to finish their own lambs if they are inclined to do so. Hence, there is not so much reason for the sale of native lambs for feeding.

Feeding areas. The principal areas of lamb feeding are in various parts of the Pacific coast states and in the parts of the Intermountain and Mountain states where there are important irrigation sections. Extensive feeding operations are also carried on in



Lambs from the ranges of the West comprise most of the feeder-lamb supply.

some of the wheat-raising sections of the states of Oklahoma, Kansas, and Nebraska. Sections of the Corn Belt states are finishing places for large numbers of range-raised lambs. In most of these states there are centers of lamb feeding, although the enterprise may be carried on to some extent throughout the entire state. There are some important feeding centers in eastern states also. There are few lambs fed in the southern and southeastern states.

Colorado has been for some years the leading lamb-feeding state and has fed more than one-fourth of all the sheep and lambs fed in the United States. There are four main areas of feeding in Colorado. The most important is in the northern part and centers around Fort Collins, Fort Morgan, Greeley, Loveland, and Sterling. These represent very productive sections where there are vast amounts of roughages, sugar beets, sugar factory by-products, and some small grain, especially barley. Much corn and protein concentrates are purchased from outside areas. The three other sections where much feeding is done are the Arkansas Valley in the southeastern part of the state, the San Luis Valley in the south central part, and the Western Slope region in the west central area.

Nebraska has two main feeding sections—the North Platte or Scottsbluff region and a rather extended area along the Platte River through the central part of the state.

In all states where lamb feeding is of importance, there is an abundance of pasture or other feeds, and the business is essentially a means of converting this material into marketable products as a profit and still retaining a good percentage of its fertilizing value.

The systems of lamb feeding vary greatly in different sections of the country. Within any one region where a more or less definite system of lamb feeding is followed, there are many differences in the practices and feeds used. The main systems and the chief features of each follow.

Field feeding. Throughout the Corn Belt, especially in the northern half of Illinois, Iowa, and northeastern Nebraska, many range lambs are fed by turning them into pasture fields or into cornfields. Frequently, the lambs are pastured in stubble fields or hay fields until available feeds are consumed, after which they are turned into cornfields to harvest at least a portion of this crop. Many farmers following this system of feeding have a companion or intercrop planted with the corn so that the lambs have a variety of feeds. Such crops as rape, rye, soybeans, or sweet clover are often used for this purpose.

Field feeding in the Corn Belt usually begins in late August or in September. Many lambs are purchased at the central markets, although there are shipments direct from western lamb-producing areas. Because of weather conditions in these regions, field feeding usually does not extend beyond November or early December, at which times most of the lambs are sold, although those not fat enough for slaughter are often held over for further finishing in dry lot and sold in January or later. Thus, many lambs are in reality fed under more than one system as here outlined.

Field feeding is also extensively followed in other sections than the Corn Belt. Thousands of lambs are fed on the wheat fields of Kansas, Oklahoma, and other states. This practice seems to be most successful in the western areas where the wheat is grown on rather dry land. Reserve supplies of dry feed for use during wet and stormy periods are considered essential. Gains of seven or eight pounds per month are often obtained, and if the feeding is sufficiently long reasonably good finish is secured. The carrying capacity of such fields varies considerably depending upon climatic and

Courtesy University of Illinois

Many thousands of lambs are fattened in cornfields during the fall months.

other factors, but a section of land will provide pasturage for from 1,000 to 4,000 lambs.

Field feeding requires relatively little labor or equipment. Fields must, of course, be well fenced, and some facilities for watering and sometimes for supplemental feeding must be provided. Since much otherwise unmarketable feed is used, the cost of the lambs is usually the chief item of expense. Death losses are sometimes higher than under other systems because the amount of feed eaten cannot be controlled. Feeders using this system generally feed from 300 to 1,000 lambs, although there are some who feed greater numbers.

Shed or barn feeding. Because of much stormy weather in the east central states, lambs are usually fed in dry lots which afford shelter. Such shed feeding is not limited to any particular area but is most extensive in northeastern Indiana, southern Michigan, parts of Ohio and New York, and in scattered localities throughout the Central States. The farmers are usually content to handle from 200 to 500 head. In many cases facilities do not permit more extensive operations, although some handle more than these numbers at one time, and others feed at least two different lots, purchasing a second group after the first has been sold. Many of these men handle lambs as a part of a diversified farming system to furnish gainful work during the winter months and as a means of conserving the fertility of the soil. The majority of these feeders produce on their farms both the roughages and grains used, although there are numerous

instances where grains and concentrates of high protein content are purchased. In other cases salvaged grains and screenings as well as good quality grains are purchased in large quantities.

Many feeder lambs are purchased on the ranges or on markets such as Denver, Omaha, Kansas City, or Chicago. Many of the lambs fed in sections east of Chicago are purchased on the Chicago market and are sold in eastern centers, such as Detroit, Buffalo, or Pittsburgh. In numerous instances this makes possible the use of the feed-in-transit privilege on a through bill of lading which results in a saving on freight costs.

In a study of lamb-feeding costs [1] on farms covering three years (1930–1933) and involving over 50,000 lambs, the costs of the lambs amounted to a little over 68 per cent of all costs. Omitting the purchase price of the lambs, feed was the most important item of expense, as it made up 75.5 per cent of the cost of fattening lambs. Remaining items and their importance were: the use of buildings and equipment constituted 9.3 per cent; interest, 5.2 per cent; labor, 5.0 per cent; other costs, 5.0 per cent. The importance of efficient, economical feeding is apparent from these percentages. Many different kinds of equipment are used by men who feed lambs in sheds. Some feeders use combination grain and hay racks or bunks, while others have separate equipment for each kind of feed.

Hand-feeding twice daily has been the most common method of feeding, although self-feeding has been introduced to a considerable extent in some localities.

Open-yard feeding. Hundreds of thousands of lambs are fed each year in open yards; that is, the lambs do not have sheds or barns for shelter. This system is followed chiefly in those sections of the West where the land is well drained and there is comparatively little stormy weather during most of the early winter. Districts where extensive yard feeding is done in open yards are Colorado, Nebraska, the irrigated sections in Idaho, and other western states where suitable feeds are available.

In most of these districts lamb feeding is an important enterprise, as it provides a market for large quantities of alfalfa hay and for by-products of such industries as the growing of sugar beets. Beet tops and beet pulp are widely used as feeds. In some of these regions grain feeds must be shipped in because sufficient quantities

[1] Mich. Quarterly Bul. Vol. 16. No. 1. Aug. 1933.

are not grown. In the beet-growing districts the manure secured by feeding lambs is highly valued as a means of helping to maintain soil fertility.

Feeders in the territories mentioned above are often large operators and may feed many thousand lambs but usually limit the number fed in any one yard to 5,000 or 10,000 head. However, not all feeders operate so extensively, many feeding from 300 to 2,500. Feeding begins in October or November, although the lambs are frequently contracted for during the summer months. Since feeders often wish to use a maximum of roughage, the feeding period usually extends for four or five months. The marketward movement of these fed lambs usually begins in January and continues in considerable volume until the spring months. Feeders generally follow the practice of sorting or topping out lambs that are of desirable finish and weight and holding the others for additional feeding.

In this system of feeding, hay is generally placed along hurdles on the ground. An opening about eight inches wide allows the lambs to reach through for the hay. Grain is placed in troughs in separate sections of the yards, especially if many lambs are being fed. Two feedings per day is the usual practice.

Lambs vs. sheep. Although the feeding business is largely one involving lambs, sheep are also fed. Lambs grow as well as fatten, and since they are much more valuable than older sheep, the gains which they make are worth considerably more. Unless feeds are very cheap and market prices of sheep high, the gains that old sheep make are likely to sell for less than the costs of the feeds. Hence, the only likelihood for profit is in the margin of selling price over buying price. This means that old sheep must be bought at a very low figure so the margin will cover all incidental costs and overcome the sale of the increased weight below the cost of its production. There are times when the gain may sell for more than its cost, but this condition does not always exist, and "cheap, old ewes" are not always profitable.

Yearling wethers have been fed in considerable numbers on pastures with very little or no grain. With the best of legume or mixed grass and legume pastures, they are put into satisfactory market condition at a very low cost for feed. Some care must be exercised in selecting them for feeding, or they will sell as wethers rather than as yearlings. The price of the former is considerably below that of yearlings because yearlings will often "break" (show

the break joint on the forelegs of the carcass) and can be sold as substitutes for lambs. Wethers sell as mutton. If bought in the spring of the year and if they show only lamb teeth at that time, they may generally be fed until early fall and sell as yearlings. However, since all sheep do not follow the general pattern of changes in their teeth with respect to age, some will show four permanent teeth and therefore sell as wethers.

Lambs make more economical gains than older sheep, but the size of the latter may enable them to make greater gains in a given period. Lambs require more careful handling than older sheep. For old ewes whose teeth are in very poor condition, grains should be ground and fine roughages are needed.

The following data are from the Montana Station [1] and cover a feeding period of 88 days.

TABLE 30

GAINS AND FEED REQUIREMENT OF SHEEP OF DIFFERENT AGES

Animal	Initial weight	Average daily gain	Feed per hundredweight gain	
			Grain	Hay
	lbs.	*lbs.*	*lbs.*	*lbs.*
Lambs	63	0.27	253	763
Yearling wethers	95	0.27	256	1,415
2-year-old wethers	116	0.28	248	1,467
Aged ewes	92	0.18	386	1,318

[1] Mont. Agr. Exp. Sta. Bul. 35.

CHAPTER 32

The Character of the Business—Economic Considerations

Those men who feed lambs soon learn that there are many important considerations in conducting the lamb-feeding business. No one is successful who lacks a fairly thorough knowledge of the most suitable practices involved in the management and feeding of sheep and who is not alert to see that the needs of the lambs are met promptly. Such knowledge and attention constitutes the feeder's chief strongholds against disastrous losses which might arise quickly because of carelessness.

Risk. In general, it may be said that lamb feeding, like most other enterprises, involves more or less risk. Risk arises through a number of avenues. Among these risks is a relatively large one involved due to the possibility of changes in the market price of lambs and their products. In case the price of lambs declines sharply between the time of purchase and the time of sale, it may be that even the original cash outlay for the purchase of the lambs will not be recovered. However, it is equally possible for the market price of lambs to increase between these two periods, and then profits may be very large because of this margin (see below). Not all people realize that this risk arises because of the danger of buying at too high a price as well as of having to sell at too low a price.

Another element of risk arises because of the possibility of excessive losses of lambs. Experienced feeders usually expect to lose 3 or 4 per cent of the lambs purchased. However, when the losses amount to 8 or 10 per cent or more, it is difficult to realize a profit unless other things are very favorable. If healthy lambs are bought and if they are given reasonable attention and are fed with good judgment, there need be relatively few cases of excessive death losses.

When undertaken by careful or experienced men, it is doubt-

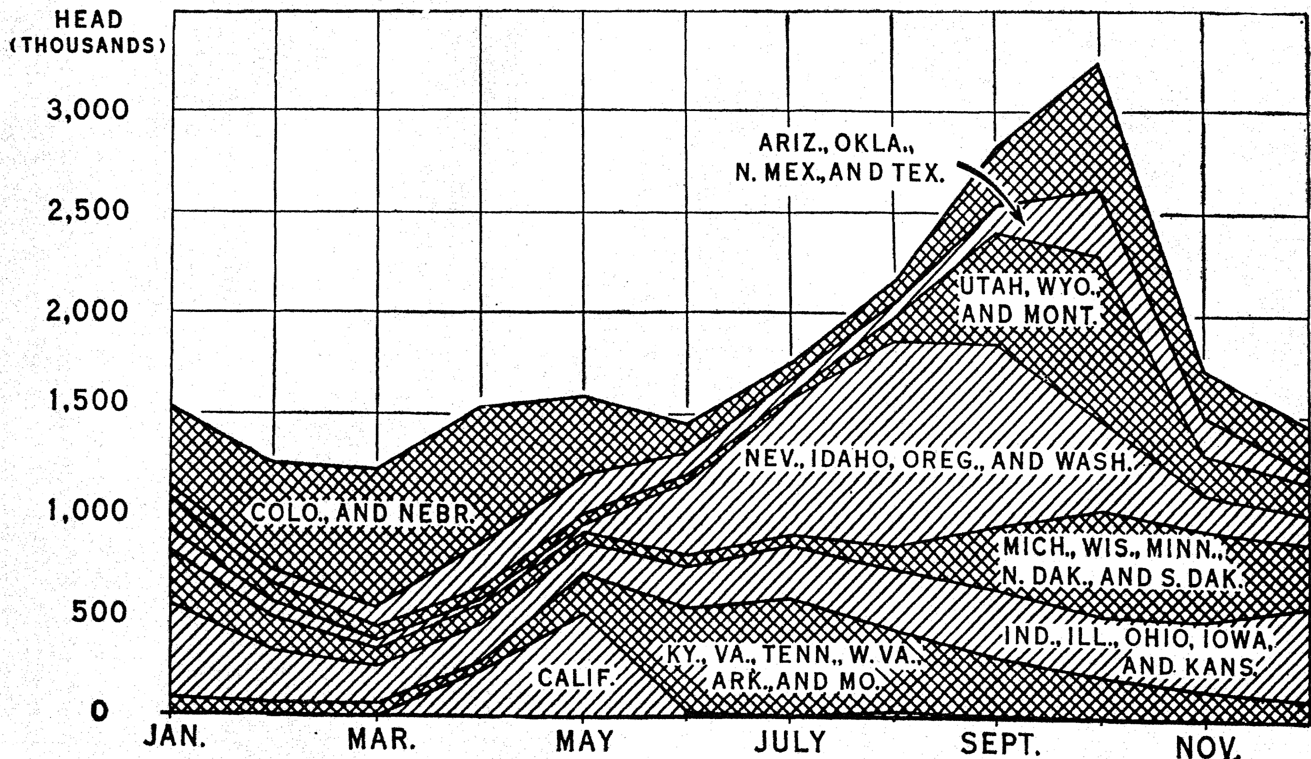
ful or at least debatable whether lamb feeding involves any appreciably greater risk than cattle feeding or many other enterprises engaged in by farmers. To be sure, profits are never assured in lamb feeding any more than in any other undertaking.

Lamb feeding represents a very flexible enterprise. If conditions seem especially favorable, the feeder may expand his operations through the purchase of more lambs or through the purchase of a second lot after one group has been sold. If on the other hand, for example, feed is scarce, fewer lambs than usual may be purchased and the size of the enterprise readily reduced. Among factors which have a bearing on probable profits and which the feeder needs to consider in studying this feature of his business are:

1. The number of lambs available for market
2. The number of feeding lambs being purchased by other feeders
3. The price of feeding lambs compared with the price of fat lambs
4. The price of wool and its bearing on lamb values
5. The general level of prices of other meat animals
6. The supply, suitability, and costs of feeds
7. The general prosperity of the people, especially in those regions where lamb consumption is large
8. Costs of handling, such as general overhead and transportation

Timely information bearing on these points may be secured from studying the reports issued by the Bureau of Agricultural Economics of the United States Department of Agriculture, as these reports are widely publicized.

Seasonal character. Lamb feeding is seasonal in character; that is, it is not conducted extensively at all periods of the year. Little feeding is done during the spring and summer months, and the lamb-feeding season is generally considered as extending from September or October to about the following May. Within recent years, however, considerable numbers of lambs from Texas and a few other areas have been bought in the spring, fed on pastures, and marketed in the late summer or fall as yearlings. Because it has been possible to buy these at relatively low prices and to secure low cost gains on them with good legume pastures, profits have been



Courtesy Bureau of Agricultural Economics, U.S.D.A.

This chart shows the origin of market receipts by months for sheep and lambs. Lamb feeding is chiefly a fall and winter business. In the period, May through November, grass-fat lambs comprise most of the market receipts, but from November through April lambs that have been fed grain are the main source of supply.

satisfactory even though the margin has been less than in the case of fall and winter feeding.

Two things are largely responsible for this usual seasonal condition. In the first place, suitable feeding lambs are not available in large numbers until the late summer and fall months. Lambs are born in greatest numbers in the spring months and, hence, do not reach market age and weight until about the fall of the year. Most rangemen are not equipped to keep their lambs long after they are removed from the summer ranges; and, therefore, many are sold on the ranges or reach the markets for sale as fat or feeder lambs at the close of the summer range season.

This corresponds with the completion of the growing and harvesting seasons, and feeders have available quantities of marketable and unmarketable feeds which they may provide for the lambs. Large quantities of unmarketable roughages accumulate, and these and the plant growth on thousands of acres of stubble fields, beet fields, and cornfields are used for feed.

Lamb feeding is more likely to prove profitable if conducted in the fall and winter, too, because of the usual tendency for increasing market prices to occur during the winter and early months of the year rather than during the summer and fall months. Thus, there is not so much likelihood of the price of lambs increasing between the months of July and October as between October and February, March, or April. The feeder cannot afford to overlook these general tendencies in considering his operations, for in such market changes rests the chief source of profit—margin.

MARGIN

Margin is the "spread" or difference between the cost price and the selling price per hundredweight. Many feeders realize that there are in reality two margins which serve as sources of profits. In addition to the buying-selling margin, there is also a possible margin between the gain cost and the selling price of the gain. Profits are largest when the feeder is able to secure margins with respect to both items. The following examples are explanatory of this.

A feeder purchases a lamb weighing 60 pounds for $7.00 per hundredweight or $4.20. If the lamb gains 30 pounds at a cost of 9 cents per pound and the fat lamb sells for $9.00 per hundredweight, the feeder has a margin of $2.00 per hundredweight on the

original purchase weight, or a total of $1.20 per lamb. This latter amount must cover all expenses and leave a balance for profit.

Using the same figures except a cost of gain of 7 cents per pound, the amount secured above purchase and gain costs totals $1.80 because of a $2.00 per hundredweight margin on the purchase price of the 60-pound lamb and also on the cost of the 30 pounds gain.

If, on the other hand, the margin applies only to the cost of gain, a $2.00 margin on these 30 pounds alone amounts to only 60 cents.

Therefore, it is very important to try to have a margin over the purchase price, although the relative importance of such a margin and a margin on cost of gain varies somewhat with various weights and costs.

If, for example, a feeder buys lambs weighing 75 pounds instead of 60 pounds and sells them at 90 pounds, a $2.00 margin over the purchase price is five times as important as the same margin on the cost of 15 pounds gain. On the other hand, if he buys lambs weighing 45 pounds and feeds them till they weigh 90 pounds, margins over purchase price and cost of gain are of equal importance. Hence, the feeder must give careful attention to the cost of gain as an important factor in determining profits.

Necessary selling price. The "necessary margin" or the margin which the feeder must have in order to "break even" is often estimated as $2.00 per hundredweight. However, no such fixed margin will cover all cases because of variations in such items as overhead, freight charges, and death losses. The "necessary margin" is calculated by first determining the "necessary selling price" by finding the total of all costs and dividing this by the weight of the lambs to be sold. Subtracting the purchase price from the "necessary selling price" gives the "necessary margin."

As a matter of fact there is no such thing as a constant necessary margin, although it may seem so to the inexperienced. The necessary margin varies considerably with the existing price levels for lambs and for feeds, with the costs of buying and selling, labor charges, interest on the investment in lambs and feeds, death losses, and shrink (which may be a part of marketing costs).

The feeder has little control over the cost of the lambs, the value of the feeds, or the price he receives for the fattened lamb. What control he has over the first and last of these items is exer-

cised through his judgment with respect to the time of purchase and sale. He may also have some control over the cost on the basis of the quality of the lambs selected and on the sale price through the quality or finish the lambs display when sold. He cannot have a great effect on the general price level, however.

While the feeder cannot have much control over the value of the feeds he uses, he can have considerable control over the costs of feed per unit of gain, depending upon the ration used and the efficiency with which the lambs are fed.

Effect of margin. That a given margin will not result in equal returns in all cases may be seen from the following tabulations. It is assumed that the feed requirement per hundred pounds gain is 400 pounds of concentrates and 500 pounds of roughage, but the actual requirement in any particular lot of lambs may be more or less than these quantities. This is 120 pounds of grain and 150 pounds of roughage for the 30 pounds gain of one lamb. For the purposes of this illustration it is assumed, too, that the general overhead is 75 cents per lamb. If more factors were included in the

TABLE 31

THE INFLUENCE OF BUYING PRICE AND SELLING PRICE ON RETURNS IN LAMB FEEDING

Buying price per cwt.	Selling price per cwt.	Return per 100 pounds of grain with roughages at various prices per ton			
65-lb. *lamb*	95-lb. *lamb*	$5.00	$10.00	$15.00	$20.00
$ 6.00	$ 6.00	.56	.25	−.06	−.37
6.00	7.00	1.31	1.00	.69	.37
6.00	8.00	2.06	1.75	1.44	1.12
6.00	9.00	2.81	2.50	2.19	1.87
6.00	10.00	3.56	3.25	2.94	2.62
7.00	7.00	.81	.50	.19	−.12
7.00	8.00	1.56	1.25	.94	.63
7.00	9.00	2.31	2.00	1.69	1.38
7.00	10.00	3.06	2.75	2.44	2.13
9.00	9.00	1.31	1.00	.69	.37
9.00	10.00	2.06	1.75	1.44	1.12
9.00	11.00	2.81	2.50	2.19	1.88
10.00	10.00	1.56	1.25	.94	.63
10.00	11.00	3.06	2.75	2.44	2.13

Each 25-cent increase in the general overhead charges per lamb would reduce the returns in the above table by 21 cents per hundredweight for grain.

tabulation, the purpose would be no better served so other factors will be treated later. It will be noted that there is a significant difference between buying feeder lambs at $6.00 per hundredweight and selling them at $8.00 and buying them at $7.00 per hundredweight and selling them at $9.00, although the margins are equal in the two cases. If the actual value of the grain is deducted from the returns shown in Table 31, the result will be the profit realized per hundredweight of gain over the charges shown.

Effect of feed requirement. The returns from lamb feeding are also significantly affected by the feed requirement per hundred pounds of gain. In the foregoing tabulation the feed requirement was assumed to be 400 pounds of grain and 500 pounds of roughage for each hundredweight gain, but in the following tabulation it is assumed that 500 pounds of grain and 600 pounds of roughage are needed to accomplish the same result. A general charge of 75 cents per lamb was used in the following calculations. In such conditions the benefit of a $2.00 margin between buying and selling prices is considerably reduced, as may be seen by comparing the return per hundred pounds of grain shown in the two tabulations. Careful

TABLE 32

THE EFFECT OF HIGH FEED REQUIREMENT ON RETURN AT VARIOUS MARGINS

Buying price per cwt.	Selling price per cwt.	Return per 100 pounds of grain with roughages at various prices per ton			
65-lb. *lamb*	95-lb. *lamb*	$5.00	$10.00	$15.00	$20.00
$ 6.00	6.00	.40	.10	−.20	−.50
6.00	7.00	1.00	.70	.40	.10
6.00	8.00	1.60	1.30	1.00	.70
6.00	9.00	2.20	1.90	1.60	1.30
6.00	10.00	2.80	2.50	2.20	1.90
7.00	7.00	.60	.30	.00	−.30
7.00	8.00	1.20	.90	.60	.30
7.00	9.00	1.80	1.50	1.20	.90
7.00	10.00	2.40	2.10	1.80	1.50
9.00	9.00	1.00	.70	.40	.10
9.00	10.00	1.60	1.30	1.00	.70
9.00	11.00	2.20	1.90	1.60	1.30
10.00	10.00	1.20	.90	.60	.30
10.00	11.00	2.40	2.10	1.80	1.50

feeding is, like margin, important, for any saving in feed used per hundredweight gain results in a greater return with a given margin.

Effect of weight. Another important consideration with respect to margin is the initial weight of the lambs. If it is assumed that all lambs will be marketed at 95 pounds and that feed requirements per 100 pounds gain are the same, the following differences will be shown by 50, 60, and 75 pound lambs. A general charge of 75 cents per head was used in all cases. Not all of the assumptions necessary to make such a comparison are likely to be sound, for the length of the feeding periods would vary, and this would influence the general charges, and the feed per 100 pounds gain would not be the same. In the table below it is assumed that the feed requirement per hundred pounds gain is 400 pounds of concentrates and 500 pounds of roughage.

TABLE 33

THE EFFECT OF THE WEIGHT OF LAMBS UPON THE RETURN WITH VARIOUS MARGINS

Weight of lamb bought	Buying price per cwt.	Selling price per cwt.	Return per 100 pounds of grain with roughages at various prices per ton			
			$5.00	$10.00	$15.00	$20.00
50	$7.00	$7.00	.88	.57	.26	−.05
60	7.00	7.00	.71	.40	.09	−.22
75	7.00	7.00	.19	−.12	−.44	−.75
50	7.00	9.00	2.07	1.76	1.45	1.14
60	7.00	9.00	2.26	1.94	1.63	1.32
75	7.00	9.00	2.86	2.55	2.24	1.93
50	9.00	9.00	1.52	1.21	.90	.59
60	9.00	9.00	1.40	1.09	.78	.47
75	9.00	9.00	.27	−.04	−.35	−.66
50	9.00	11.00	2.57	2.26	1.95	1.64
60	9.00	11.00	2.76	2.45	2.14	1.82
75	9.00	11.00	3.37	3.06	2.75	2.44

The above figures do not mean profit or loss per lamb but indicate the return per 100 pounds of grain eaten. The amount of grain eaten per lamb would be different in each weight, but it is assumed that the amount required for 100 pounds gain is the same for the three weights of lambs. These calculations pertain to individual lambs. If the assumptions above held true, it would not

make any difference whether the feeder bought light or heavy lambs if he bought the same total weight and put on the same total gain and hence sold the same total weight. This is not often done in practice, and there are usually some price differences between various weights of feeder lambs.

Margin and costs. Another illustration of the changes in the necessary margin with feeder lambs at various prices is given in the following tabulation. In this it is assumed that corn worth $20 per ton and alfalfa hay worth $10 per ton are fed and that 400 pounds of corn and 500 pounds of hay are needed for each 100 pounds gain in weight.

TABLE 34

NECESSARY MARGIN WITH VARYING BUYING BUT CONSTANT OTHER COSTS

Cost of lambs per cwt.	$6.00	$7.00	$8.00	$10.00	$12.00
Cost of a 60-pound lamb	3.60	4.20	4.80	6.00	7.20
Cost of feed for 35-pound gain	2.28	2.28	2.28	2.28	2.28
Overhead charges	1.00	1.00	1.00	1.00	1.00
Total cost of lamb delivered to market	6.88	7.48	8.08	9.28	10.48
Necessary selling price	7.24	7.87	8.50	9.76	11.03
Necessary margin	1.24	.87	.50	−.24	−.97

Overhead charges would not remain the same in all price levels, although these items do not fluctuate so much as other items that influence the margin, unless it might be the matters of interest and death losses. There is another item in overhead charges that shows more fluctuation, and that is the matter of shrink in shipment.

Shrink. In any discussion of shrink it must be assumed that accurate weights are involved. If either the buying or selling weights are inaccurate, there are certain to be fluctuations in costs and returns; but shrink refers to the loss in weight in transit and must be limited to its causes and extent. Most shrink is due to loss of intestinal contents and moisture. So long as the change in weight of the lambs while they are en route is due to these matters alone, shrink is not an item of great consequence, as it is readily regained. If shrink exceeds this loss, there is a loss of body substance, and this is more costly to replace. Careful management during shipment is the only means whereby this may be prevented. Involved are the manner of loading, number per car, weather conditions en

route, feeding intervals en route, delays, method of handling on arrival at the feed lot or market, and the finish of the lambs. Fat lambs shrink less than feeder lambs under the same conditions. The percentage shrink on fat lambs shipped under good conditions a distance of 250 miles will approximate 5 per cent. Carefully managed en route and fed, watered, and rested before weighing, many lambs have been shipped 1,000 to 1,500 miles with about the same percentage shrink.

Summary. The higher the price levels for feeder and fat lambs the less the necessary margin, if there is a certain feed price level. If all costs advanced exactly in accordance with the prices of lambs, price levels would have no effect upon the necessary margin. High feed prices increase the necessary margin regardless of the price of feeder lambs. There are few cases when there is no margin needed for a reasonable profit. At high price levels for fat lambs, the return for the feed fed tends to reduce the importance of the other items of cost. The necessary margin is thereby lowered. The farm feeder who produces his own feed is much better off when he is operating under high lamb prices, for this gives him a greater value for the feed he markets through the lambs. Operating at high levels at time of purchase of feeder lambs and at low levels at the time of their sale is, of course, disastrous.

COSTS IN LAMB FEEDING

A great variety of items enters into the costs of lamb feeding. These costs vary from year to year and from one season to another of the same year. There are likewise great differences in costs in different localities and among feeders within a locality. Other variations in costs arise because of differences in the costs of lambs, methods of feeding, kinds and costs of feeds, length of feeding period, rate of gain, charges for equipment and labor, death losses, general overhead such as transportation, interest, marketing charges, and so forth.

Cost of lambs. It is generally true that the cost of the lambs is the largest single item in the total cost of feeding lambs. The purchase price usually represents from 50 to 75 per cent of all costs, depending upon the kind of lambs, time of purchase, and method of feeding. If very small or very cheap lambs are bought and if they are fed in dry lot, their initial cost will represent a relatively small percentage of the total cost of the finished lambs on the market.

During the years 1930–1935, the cost of lambs weighing approximately 65 pounds has represented from 53 to 70 per cent of all costs for Michigan feeders. Heavier lambs fed for a short period would show a higher percentage of all costs represented by the initial cost, especially if part or all of the feeding were done in the fields when only a small charge would cover the value of the feeds used. Since the purchase price of the lambs is such an important factor in costs, the feeder must be alert to keep this item as low as possible. The time of purchase is often important in accomplishing this.

Feed cost. Feed cost is the item of next importance, although there are times when this will be of more consequence than the cost of the lambs. Usually, however, feeds will range from about 20 to 40 or 50 per cent of the total cost. In many instances the feed cost will represent at least 75 per cent of all costs other than the price of the lambs. This item is influenced chiefly by the size or weight of the lambs, method of feeding, length of feeding period, rate of gain, and the kinds and prices of feeds. For heavy lambs feed represents a lower percentage of all charges than for light lambs. This does not mean that light-weight lambs do not make efficient use of their feed, but, because a greater weight increase is necessary, they must be fed for a longer period than heavy lambs; and, hence, the feed cost of this gain would be greater in proportion to the initial cost of the light-weight lambs. To feed for a long period requires greater quantities of feed, and this tends to increase the relative importance of feed costs. Rapid gains are generally economical; slow gains require greater amounts of feed and also tend to increase the feed cost in relation to other items. Feeding during any season when feed costs are high in relation to lamb prices will show a relatively high feed cost compared with other items of expense. In dry-lot feeding, the cost of concentrates is likely to surpass the cost of roughages, especially if some of the roughages fed are of low market value. If, however, roughages of good quality are fed, the proportion of concentrates to roughages may be varied so that rather large quantities of roughages are utilized, and their cost will then be high in comparison with that of concentrates. Field feeding during the autumn months generally shows a lower percentage of all costs represented by feed than other methods.

Skillful feeding, which maintains the health of the lambs and promotes rapid gains, results in a low feed cost per pound of gain. High feed costs are certain to arise if poor rations are used, and the

lambs make slow gains as a consequence. Important items of cost are shown in the following table.

TABLE 35

FIVE-YEAR LAMB-FEEDING COSTS IN MICHIGAN[1]

Feeding year	1930–31	1931–32	1932–33	1933–34	1934–35	Average per cent of total
Total no. of lambs	20,642	10,898	21,833	40,047	35,147	128,567
Charges						
Lambs	$ 5.05	$ 3.69	$ 3.30	$ 4.04	$ 4.15	63.94
Grain & roughage	2.00	1.29	1.07	1.69	3.25	29.39
Labor	.15	.11	.07	.11	.13	1.80
Use of buildings and equipment	.19	.11	.13	.12	.13	2.15
Interest on lambs	.09	.07	.08	.09	.08	1.29
Shearing and other costs	.12	.09	.07	.07	.10	1.42
						Av. 5 yrs.
Total charges	$ 7.60	$ 5.36	$ 4.72	$ 6.12	$ 7.84	$ 6.33
Credits						
Lambs sold	$ 7.47	$ 5.42	$ 4.77	$ 7.12	$ 7.24	$ 6.40
Lambs butchered	—	.01	.01	.12	—	.03
Wool and pelts	.26	.07	.55	.47	.46	.36
Manure	.27	.22	.20	.20	.19	.22
Total credits	$ 8.00	$ 5.72	$ 5.53	$ 7.91	$ 7.89	$ 7.01
Profit	$ .40	$ .36	$ .81	$ 1.79	$ .05	$ .68
No. of farms	29	15	30	50	40	
No. of lambs per farm	712	726	727	767	879	762
Av. initial wt. per lamb	67	67	64	62	62	64.4
Av. gain per lamb	20	18	22	23	29	22.4
Av. feeding period, days	97	110	112	116	111	109
Av. cost per cwt. at farm	$ 7.15	$ 5.47	$ 4.93	$ 6.23	$ 6.30	$ 6.02
Av. sale price per cwt. at farm	8.58	6.36	5.52	8.23	8.16	7.37
Margin per cwt. at farm	1.43	.89	.59	2.00	1.86	1.35
Death loss, per cent	2.5	4.0	4.5	4.2	5.3	4.1
Lbs. concentrates a lb. gain	6.3	6.8	6.6	6.4	5.8	6.4
Lbs. roughage a lb. gain	6.0	5.7	5.7	5.6	5.2	5.6
Feed cost a lb. gain	$ 0.098	$ 0.07	$ 0.049	$ 0.073	$ 0.129	$ 0.084
Total cost a lb. gain	.125	.09	.064	.09	.146	.103

Labor and equipment. Charges for equipment and labor vary widely. Equipment charges are of course highest where lambs are fed in barns or sheds and lowest where open-lot or field feeding can be followed. Labor charges probably vary similarly. Charges

[1] Mich. Agr. Exp. Sta. Spec. Bul. 284.

for these two items per lamb are influenced by the number handled. Feeders who handle large numbers are likely to have the lowest equipment and labor costs per head. It is not unusual for some feeders to purchase more than one lot of lambs during the feeding season and thus make use of the available equipment over a longer period with a consequent reduction in cost per lamb. Labor costs will usually represent from 1 to 3 per cent of all charges, and use of buildings and equipment, from 2 to 3 per cent. Interest charges vary considerably depending upon rates, value of lambs, and length of feeding period, but usually will not exceed 2 or 3 per cent of all charges. Miscellaneous items are usually a factor of minor importance. The value of the manure produced by the lambs is generally considered equal to the cost of labor. Its value is sometimes greater than the labor charges.

Death. An important item in the costs of lamb feeding is death loss. In some cases losses from death may be offset or overcome because of very favorable conditions otherwise so that a fair profit is obtained. The death of a lamb increases the margin which the feeder must have, as it represents the loss of most of the original investment and of other items. Salvaging the pelts may aid in recovering part of the cost. Heavy mortality, unfavorable market prices (both buying and selling), and high feed costs are the chief factors in a disastrous season. The importance of death losses in increasing the necessary margin varies to some extent with all items of cost, but the ones of most influence are the buying price of the lambs and cost of feeds. The following tabulation shows the impor-

TABLE 36

INFLUENCE OF DEATH LOSS ON NECESSARY PRICE PER HEAD

Death loss per cent	Average value of lambs per head						
	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00	$10.00
No loss	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00	$10.00
1	3.03	4.04	5.05	6.06	7.07	8.08	10.10
2	3.06	4.08	5.10	6.12	7.14	8.16	10.20
3	3.09	4.12	5.15	6.18	7.21	8.24	10.30
4	3.12	4.16	5.20	6.25	7.29	8.33	10.41
5	3.15	4.21	5.26	6.31	7.36	8.42	10.52
7	3.22	4.30	5.37	6.45	7.52	8.60	10.75
10	3.33	4.44	5.55	6.66	7.77	8.88	11.11
12	3.41	4.54	5.68	6.81	7.95	9.09	11.36
15	3.53	4.70	5.88	7.05	8.23	9.41	11.76

tance of death losses with varying values of lambs as a necessary increase in the value of the remaining lambs if this loss is to be offset. Thus, if the loss of lambs is 5 per cent and the total investment in each at the time of its death is $5.00, the remaining lambs must bring $5.26 each to cover this loss. If the investment is $8.00 per head, then the corresponding figure for a 5 per cent death loss would be $8.42 per head.

This table also applies if death loss is based on a percentage of the weight. Thus, if enough lambs are lost to reduce the total weight of the lambs marketed by 5 per cent, the remaining lambs, to cover a total investment of $8.00 per head, must sell for $8.42 per hundredweight instead of $8.00 if there had been no losses.

The most common causes of death of feeder lambs are discussed in Chapter 40.

CHAPTER 33

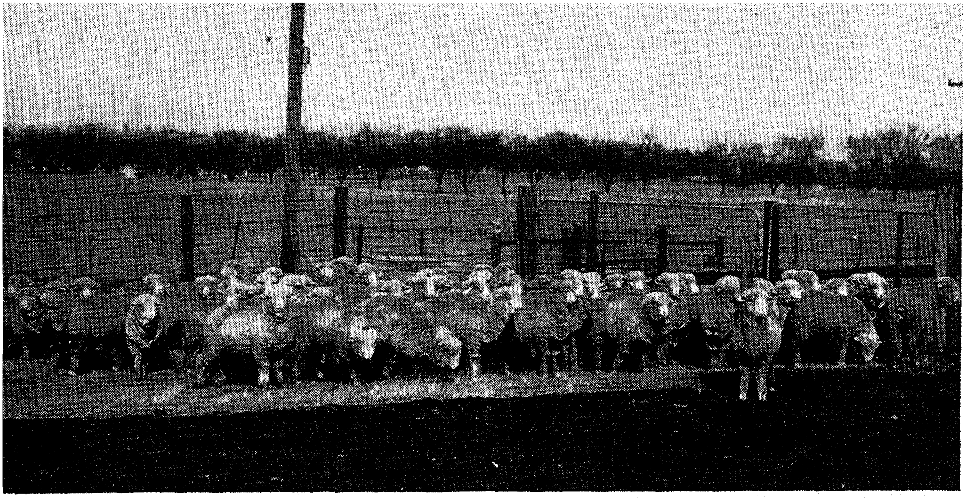
Selection and Purchase of Feeder Lambs

The selection and purchase of feeding lambs are important phases of the feeder's business. The kinds of lambs available, their relative costs, their response in the feed lot, and their relative values when fat demand careful study. There is much prejudice on the part of some feeders against lambs of a particular type or from a particular locality. Some of these prejudices are well founded, but others are not supported by experimental evidence. The good feeder lambs are not all to be found in any one section, and there are so many variations within breeds and general types of lambs that even here there are opportunities for the use of good judgment that may have a great influence on profit.

Lambs vary greatly in breeding or type, color of face, character of pelt, size or weight, form, quality, fleece, condition, constitution, and health. The place or region in which the lambs were raised is related to the kind of management that they should have. This is true because of the prevalence of internal parasites in some areas and their almost complete absence in others.

Breeding. Very often feeders have a decided preference for lambs of some particular breeding. Practically all lambs from the western ranges carry some fine-wool blood, especially that of the Rambouillet, which is a white-faced breed of fair mutton qualities. The last few years have witnessed great improvement in the Rambouillet in some features relating to its feeding qualities. In a few areas Merinos are rather common. They are smaller than the Rambouillet, as a rule are not so well made, and hence may lack the capacity for rapid gains that lambs of the Rambouillet breed possess.

Many experienced feeders like the smooth-bodied, large-framed, open-faced Rambouillet lambs; but they are careful to

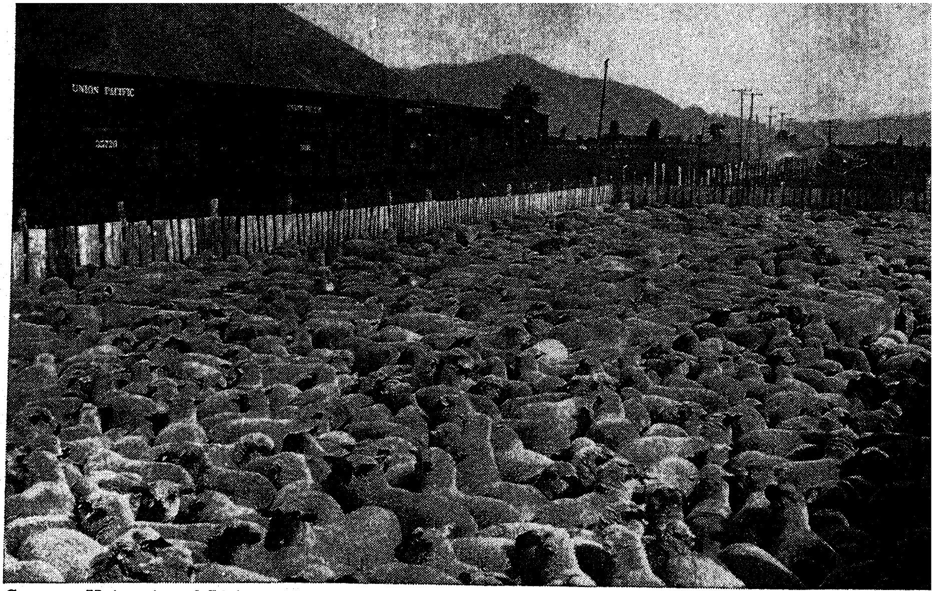


Courtesy University of Illinois

These fine-wool feeder lambs sell for less than lambs of more pronounced meat type. Producers are emphasizing improvement in form and general quality, and feeders are demanding freedom from skin folds.

avoid the fine-boned, wrinkly, woolly-faced kind that appear to lack constitution and vigor. Lambs of these breeds are said to be "pelty," "wrinkly," "heavily marked," or "hidy" if they have many folds in the skin. Such lambs are lacking in quality and yield a lower percentage of carcass when slaughtered than smooth-skinned lambs, and they are often so angular in form that their carcasses are not among the choicest. Such lambs do not attain an even finish, and many lots of them prove unsatisfactory as they do not make economical gains. This was at least partially confirmed in comparisons in New Mexico which showed heavily wrinkled lambs made lower gains than either medium-pelted or smooth-pelted lambs.[1] Smooth-skinned, well-made lambs of fine-wool breeding are not subject to these criticisms. Because such lambs carry rather heavy fleeces of fine-wool they may be shorn before marketing. While high-quality, fine-wool lambs may not gain so fast as lambs carrying some medium-wool breeding, the differences between lots of comparable quality are not great. Good fine-wool lambs are very hardy, and their dense fleeces offer considerable protection in cold, wet weather. Present prices of feeders make it possible to buy fine-wool lambs cheaper than lambs of medium-wool breeding. The best fine-wool fat lambs sell at better prices than any but the best lambs of other types. Lambs of this breeding come from all areas

[1] N. Mex. Bul. 309.



Courtesy University of Idaho

Western black-faced feeder lambs are popular in many sections. Since many black-faced lambs are fat, feeders are sorted from shipments containing both fat and feeder lambs.

of the West, but those from the southwestern sections are mainly of this type.

Crossbred lambs may be either white- or dark-faced. White-faced crossbred lambs are produced by breeding fine-wooled ewes to medium- or long-wooled, mutton-type rams of the Corriedale, Columbia, Lincoln, Cotswold, or Romney breeds. Because of their longer fleeces they appear somewhat larger than fine-wool or black-faced lambs of the same weight. These white-faced lambs are generally good feeders and make good or choice grade carcasses if well finished. Some of them may not finish at the most popular weights, however; but this is also true of other types. They are good for shearing before marketing, as their fleeces are long and of good weight. Most lambs of this kind are from the western or northwestern ranges.

Black-faced lambs are the result of breeding either fine-wooled ewes or white-faced crossbred ewes to dark-faced, medium-wool rams. Many lambs produced in this way are mottled or speckled-faced. More Hampshire rams than those of any other breed are used for the production of such lambs in the range country. The Suffolk has gained in popularity, and there are many crossbred Hampshire-Suffolk rams used. This has come about because the Suffolk lambs

grow rapidly and because the Suffolk is a "clean-headed" breed that is not subject to wool blindness. These lambs do well in the feed lot as they make fast and economical gains and attain a very desirable finish, with the result that they dress a satisfactory percentage of carcass. They are among the most attractive lambs in their general form and quality, and because they have generally proved satisfactory they sell for a higher price than other feeding lambs. They are probably a little less hardy than the best of the fine-wools. The packer buyers show the same preference for dark-faced lambs as the feeders, but the increased price for them compared with equally well-finished fine-wools is not sufficient to offset the higher cost as feeders. They are therefore not always the most profitable kind.

Navajo lambs from sections of the Southwest are a more or less distinct type. Efforts to improve them are now being made, but they are small-framed, fine-boned, open-fleeced, and often there are several colors among them. They are generally hardy and yield attractive carcasses.

Lambs representing the four general types were used in tests at the Purdue Experiment Station for comparisons that covered four different feeding years. The average length of the four periods was 74 days, and the rations for all lots of lambs during the four periods consisted of shelled corn, cottonseed meal, corn silage, and clover hay. The results of the comparisons showed no strong contrasts in the lots with respect to gains, feed required, feed costs, or profit and loss, although the Rambouillets were lowest in gain and highest in feed required.

TABLE 37

AN AVERAGE OF FOUR YEARS' RESULTS IN FEEDING LAMBS OF DIFFERENT BREEDING

Breeding of lambs	Rambouillet	Corriedale	Hampshire × Rambouillet	Hampshire × Corriedale
Average daily gain, lbs.	0.31	0.33	0.34	0.33
Feed per cwt. of gain, lbs.				
Concentrates	409	380	372	376
Corn silage	454	421	412	417
Clover hay	453	421	413	417
Cost per cwt. of gain	$ 11.40	$ 10.58	$ 10.36	$ 10.48

The report of the work [1] contains the following statements: "In finish and valuations of the various lots at the close of the experiments, the Corriedale blood in both the high grades and the crossbreds was regarded with favor. It was not so much a question of fatness as the fact that these lambs always had a good finish and were usually lighter in weight than the Hampshire-Rambouillet crossbreds. Those who valued the lambs always criticized the Hampshire-Rambouillet for being heavy in weight and slightly coarse. They never criticized their fatness. The Rambouillets were never quite as fat as the other groups or quite as uniform in their finish, and the fact that they were always slightly pelty reduced the valuations on this group."

Weight. Because weight is often an important factor in determining the prices of fat lambs, the feeder buyer must include weight in his considerations of value. At most times the desirable weight of fat lambs is from 85 to 90 pounds; hence, feeder lambs that will be well finished when they have attained a weight of 85 to 95 pounds will be likely to prove most satisfactory.

For the majority of feeders medium or handyweight lambs (those weighing 55 to 65 pounds) will be most suitable, for they can be finished in a reasonable time at good weights. They have enough age and vitality to respond well to feed and will finish in the usual 90 to 120 day feeding period. Because of the numbers available they may be obtained in uniform lots.

Heavy feeder lambs (70 to 75 pounds) that are very thin may not be so satisfactory as those of lighter weight; they are likely to be too heavy if fed sufficiently long to be well fattened or to lack finish if returned to market at weights of 85 to 90 pounds. At present there is no discrimination against heavy slaughter lambs. If they have considerable fat when put into the feed lot, they may be given a heavy feed for a short period and large gains secured.

Lambs known as light-weight feeders weigh from 45 to 55 pounds. They are often referred to as "pewees." Usually they are not available in great numbers because they are generally produced only under the most unfavorable conditions. These pewees are satisfactory for a rather long feeding period and often develop into choice-grade fat lambs. Many feeders prefer to shear them in the late winter or early spring months before shipping them to market, especially if wool is bringing a good price and the market dis-

[1] Purdue Agr. Exp. Sta. Bul. 343.

count on shorn lambs amounts to less than the value of the wool. These lambs often make cheap gains and are suitable for those feeders who have relatively large amounts of roughage and little grain. This is the safest feeding program for light-weight lambs and is the best means of keeping death losses low. The feed required per hundredweight gain is likely to be less than with heavier lambs; hence, with cheap roughages and costly grains they may be the most profitable kind to feed. The light-weight lambs can be bought cheaper than either medium or heavy lambs, and the chances for a good margin is therefore favorable.

In tests conducted in Idaho,[1] lambs weighing about 54 pounds gained 96.4 per cent as much as those weighing about 64 pounds. The light lambs required 5.3 per cent less hay and 9.9 per cent less grain than the larger lambs for each hundred pounds of gain. In Illinois[2] trial lambs that weighed 50 pounds were compared with others that weighed 79 pounds. The former gained 0.31 and the latter 0.29 pound daily. The light lambs required 68 pounds less corn and 349 pounds less corn silage per hundredweight gain. A summary of data from Colorado[3] showed 41 pound lambs gained at the rate of 0.27 pound daily while 60 pound lambs gained 0.29 pound. Further calculations showed the light lambs had gained 94 per cent as much as the heavier ones but had required only 85 per cent as much grain and 89 per cent as much hay for each 100 pounds of gain. At Minnesota[4] 46.6 pound lambs and 60.1 pound lambs were compared in a 76-day test. The light lambs gained 0.39 pound and the heavier ones 0.40 pound daily. To produce 100 pounds gain, the light lambs ate 452 pounds of concentrates and 241 pounds of roughage; the heavier ones ate 503 and 252 pounds of concentrates and roughages.

There is more to the selection of feeder lambs than choosing some particular breeding, color of face, or weight. Quality, form, condition, constitution and health, and fleece are all given consideration by careful feeders.

Quality, condition, and form. These three things vary greatly in feeder lambs. The most satisfactory lambs are those which show good general quality. Such lambs are free from coarseness, paunchiness, and peltiness.

---

[1] Idaho Bul. 194.

[2] Ill. Project 333.

[3] Colo. Bul. 379.

[4] Minn. Mimeo. Rpt. S/7, 1/18/30. Morris.

A moderate amount of condition is desirable in feeder lambs. Extremely thin lambs are often lacking in vitality and vigor and do not have the ability to do as well as those carrying a small amount of fat. The emaciation may be due to internal parasites or some other condition difficult to overcome.

Along with quality and condition is the matter of form. Moderately lowset or short-legged, compact lambs are more attractive than those that are long-legged and rangy. The wide, deep-bodied, straight-backed lambs not only make the most satisfactory gains and attain the best finish, but they sell for the highest prices when finished because of the attractiveness of their carcasses. The form of lambs is influenced a great deal by fat, but it is impossible to make a rough, angular lamb attractive. A comment regarding these matters is found in Bulletin 309 of the New Mexico Station. "Much variation in rate of gain was found within groups of lambs of the same breeding and of nearly identical conformation and finish. In other words, some lambs do well and some poorly regardless of breed, shape, or size. The ability to gain may be inherent within the lamb and may allow for selection for good ability to gain in the feed lot."

Constitution and health. A strong constitution and good health are absolute requirements if feeder lambs are to withstand heavy feeding and the hardships frequently met in shipment and in the feed lots and fields. Lambs that are unthrifty because of infestation with internal or external parasites or because of some other condition introduce an additional hazard into the feeding operation and therefore must be bought at a considerable discount. A top price for feeders is justified only if there is reasonable assurance that they can be developed into top-priced fat lambs. The general appearance, alertness, movement, and freedom of tagginess or other evidence of scouring are all indicative of health. Good fleeces are important in protecting and safeguarding health.

Wool. Wool is important in selecting feeders because it has a bearing on the value of the lambs; it is a protection to them, and it seems to be associated with the finish lambs attain.

For field feeding, tight-fleeced lambs are preferable to those with shaggy coats, as a tight fleece gives more protection than a loose one. Densely fleeced lambs are also more attractive because of the "bloom" the fleece acquires. Some sheepmen say they have a better "touch" when handled for finish or amount of fat. Shaggy-

coated lambs are not likely to attain a hard, thick finish. However, it is undoubtedly true in many cases that such lambs gain as rapidly as those carrying somewhat tighter fleeces.

Uniformity needs to be emphasized in feeder lambs if only a small number are being fed. An even lot of feeders is much more attractive than a lot of all colors, sizes, and shapes. Furthermore, buyers do not insist on sorting a uniform lot of fat lambs and buying part of them at a considerable discount. It is always a satisfaction to a feeder to have his lambs sell "straight" at the top price for the day, when he returns them to market. Of course, large lots of lambs may be "shaped up" into uniform lots before they are shipped.

Grades of feeder lambs. The features described are the chief ones considered in placing feeder lambs in the various market grades. Lambs possessing *all* these desirable features to a very great extent are known as *choice feeders.* Choice-feeder lambs would be moderately lowset, straight, deep, wide, smooth-skinned, without any suggestion of coarseness or wastiness in make-up, carrying a small amount of fat, be very alert and healthy. There is no question about their being choice or prime (top grade) fat lambs when they are finished. As desirability or attractiveness in one or more respects declines, the lambs are designated as *good, fair* or *medium,* and *common* or *inferior* feeders. Usually the lower-grade feeder lambs will not develop into the higher-grade fat lambs and, therefore, they command lower prices per hundredweight. In some cases, however, careful feeders make choice fat lambs from cheap feeders.

Range or native feeders. Range or western lambs are raised west of the 100th Meridian, chiefly in western Texas and in the Rocky Mountain and Pacific coast states. Range lambs are often designated by the name of the state in which raised, as for example, Texas, Idaho, or Montana lambs. The region from which lambs come is important because conditions are apt to be more favorable in some sections than in others for them to become infested with internal parasites. Thus, on the high mountain ranges of the central and northern parts of the range area, internal parasites are less common than in the southern portion. Parasites were formerly troublesome to sheep only in the central and southern states, but in recent years they have become a more serious problem in some sections of the southwestern and western range area. Aside from this consideration and the differences in breeding, the differences

between lambs from the northwestern or southwestern range country are not likely to be great. However, some feeders believe that lambs from the more northern area become acclimated to Corn Belt feed-lot conditions more quickly than do those from the Southwest. In other areas these considerations may be somewhat different.

In addition to these considerations concerning the sections from which range lambs may be secured, there is, especially in the Central States and in some other sections, the possibility of using native or farm or ranch lambs. Native feeders are not available in such large numbers as western feeders, but in many communities or on some of the central markets thin native lambs can be obtained in sufficient numbers to supply the needs of feeders who do not care to feed more than several hundred head. Generally, feeders have been warned not to attempt to fatten thin native lambs because they are very likely infested with stomach worms, and results would be disappointing. With more information about methods of treating parasitized lambs, however, careful feeders may expect to secure good results from these native lambs.

Rations that are satisfactory for western lambs are also satisfactory for natives. The latter must be started on feed more carefully, and it may take a longer feeding period to properly fatten them, if they are very thin because of parasites. It would be inadvisable to feed any lambs from the Central States without first treating them for the removal of intestinal parasites.

Comparisons of western-range lambs with native medium-wool and fine-wool lambs have been made at some experiment

TABLE 38

AN AVERAGE OF TWO TRIALS COMPARING WESTERN RANGE LAMBS WITH NATIVE LAMBS. MICHIGAN DATA[1]

	Western lambs	Native medium-wool lambs	Native fine-wool lambs
Number of days fed	88	77	84
Average daily gain, lbs.	0.39	0.41	0.33
Feed per 100 pounds gain			
Shelled corn	290	267	315
Linseed oil cake	41	38	45
Corn silage	276	258	306
Alfalfa hay	383	334	384

[1] Mich. Agr. Expt. Sta. Rpt. Bien. 1930–32.

stations. In Michigan the lambs were rated in the following order for rate and economy of gain as an average of two trials: medium-wool natives, westerns, and fine-wool natives.

Several reports of comparisons at the Ohio Station show essentially the same results. When the native lambs had been successfully treated for the removal of parasites, they made a good showing. The results are not consistently in favor of any group, but they do show the possibilities of salvaging thousands of native lambs through intelligent and modern treatment. The development of phenothiazine as an anthelmintic for the destruction of parasites further advances these possibilities. The range lambs in this case were described as choice black-faced feeders. The native medium-wool lambs were of mixed breeding and grade, and the fine-wool lambs were both smooth and heavy pelted. The lambs were all shorn before marketed.

TABLE 39

COMPARISON OF TWO TYPES OF NATIVE AND WESTERN LAMBS. OHIO DATA[1]

Kind of lambs	Western	Native mutton	Native fine-wool
Days fed	105	105	105
Average daily gain, lbs.	0.36	0.36	0.29
Feed for 100 pounds gain			
Shelled corn, lbs.	415	374	447
Linseed oil cake, lbs.	42	42	52
Mixed clover hay, lbs.	286	276	329
Average fleece weight, lbs.	5.4	5.7	8.2

There is yet another kind of lamb found in considerable numbers on markets. This is the native ram lamb. There are many of them that are thin, and some have been bought as feeders. They may be had at a low price. It is possible to treat such lambs for parasites, castrate them, and feed them into reasonably good fat lambs. Even if not castrated, these ram lambs properly treated may be expected to make rapid gains in weight, but their carcasses will not be the best, and they will sell at some discount. The Ohio[2] Station published data on one test in which the following results were obtained. (See Table 40 on page 357.)

[1] Leaflet Ohio Livestock Day. April 25, 1924.
[2] Ohio Bi-monthly Bul. Vol. 13. No. 3. June, 1928.

TABLE 40

RAM LAMBS COMPARED WITH EWE AND WETHER LAMBS AS FEEDERS

Kind of lambs	Ram	Ewe and wether
Number of lambs	18	27
Days fed	134	134
Average initial weight, lbs.	59	61
Average daily gain, lbs.	0.37	0.32
Feed per 100 pounds gain		
Shelled corn	340	352
Oats	1.7	1.5
Linseed cake	40	45
Alfalfa hay	312	387
Final value per lamb	$ 11.91	$ 14.85

Buying feeder lambs. The central livestock markets, such as Chicago, Omaha, Denver, Fort Worth, and others, are important centers for the purchase and sale of lambs. Here the buyer may purchase feeder lambs from commission men or dealers having them for sale, or he may place his order in the hands of a commission firm to execute for him. This is true of all public markets, although some are much more important than others as sources of feeder lambs. No one market, however, has a monopoly on lambs, and feeders should make their purchases wherever they can obtain the best value. The choice of a place of purchase will be determined particularly by the kind of lambs available, their cost, and the freight rates to feeding point.

While it is advisable for a feeder to see the lambs he considers buying before he purchases them, it is seldom necessary to take expensive trips to buy one or two decks of lambs, for the services of well-qualified, reliable buyers may be obtained on all markets. If these buyers are carefully informed regarding the kind of lambs wanted, they will generally endeavor to fill the order to the satisfaction of the buyer. On the central markets feeder lambs are usually sorted from large shipments that contain both fat lambs and those suitable for further feeding.

Agencies exist also for the purchase of lambs direct from the range grower, without his shipping lambs to the central markets. Dealers or marketing associations often perform this function, although there are many feeders handling lambs in large numbers and dealing direct with the producer. Feeders may contract during the summer with producers to have their lambs delivered to their

Courtesy University of Illinois

Unloading for feed, water, and rest while en route from the range to a feed lot is an important matter in feeder-lamb management.

feed yards during the fall. A certain amount is usually required as a down payment, the balance being due at the time of delivery. In buying lambs in this way, it is customary to allow them a normal "fill" and then to shrink them for 12 hours by withholding feed and water. At the end of that time they are weighed and "received." If the lambs are not shrunk in this way, the purchaser is usually allowed to deduct three or four per cent from the weight in calculating the cost. Contracts for the purchase of lambs should be specific regarding grade and minimum weights, price, method of weighing, and date and place of delivery.

Contract feeding. Because of the inability of many feeders to obtain cash for the purchase of lambs, some dealers and producers have arranged to have their lambs fed according to a more or less definite agreement. This is known as contract feeding. Contract feeding has been commended by some and condemned by others. Such an arrangement has generally proved satisfactory when both parties have been trustworthy and they have used a fair, clear contract. Whenever the owner supplied poor lambs which did not

suit the feeder or whenever the feeder gave the lambs poor feed and care, dissatisfaction arose.

An equitable contract is an extremely important element in contract feeding. Each party to the agreement must understand the other's viewpoint and problems and know in advance all details regarding the lambs, method of feeding, supervision, responsibility for death losses, and marketing.

Four general types of contracts have been used which may be designated as: (1) guaranteed-price or spread contract, (2) feed-cost contract, (3) gain-in-weight contract, and (4) cooperative-share contract.

The salient and distinguishing features of each are as follows, according to Idaho Bulletin 194. In the guaranteed-price contract the lambs are weighed to the feeder at a certain agreed price per hundredweight and are then resold at once to the owner at an agreed price and approximate delivery weight. The owner will usually call for delivery of the lambs when they weigh about 90 or 95 pounds. The feeder price may be from one to two dollars per hundredweight below the price for the fattened lambs. If lambs are very high and feed costs very low, the deal may not involve any price difference between feeder and fat lambs.

The second type of contract involves the sale of feeds to the owner of the lambs with the stipulation that the lambs will be brought to the farm for feeding, which is usually supervised by the owner of the lambs. The feeder is paid for his services in feeding and caring for the lambs either by being paid a higher price than prevails for feeds or is paid wages according to the number of lambs involved. The feeder may also provide water, bedding, and equipment at an agreed price, or part of these may be furnished by the owner. If the feeder is paid by a higher price for his feeds, he may receive an extra dollar per ton for hay and silage and two or three dollars per ton more for his grain.

Under the third type of contract the lambs are weighed at the time of delivery to the feeder, and he is paid at an agreed rate for the gains the lambs make. The payment varies with the type of feeding used and the prevailing value of lambs at the time the contract is made. For pasture feeding the price may be from 6 to 8 cents per pound gain, and for dry-lot feeding it may vary from about 7 to 12 cents. Prices paid would vary in different regions and under different price conditions for lambs and feeds. The contract

should be specific in regard to weighing, payment of freight, death losses, and probable length of feeding period. If the producer pays all the expenses and stands all of the death losses, the rate paid the feeder is lower than if these are shared. In some cases the death losses are shared by both parties. In others the owner will stand the loss up to two or three per cent or whatever is agreed to as a "normal loss." In some cases the feeder is asked to stand all of the death loss as this may make him more careful in the feeding operations.

In operating under a cooperative share contract the parties determine the values of the materials that each has contributed, and when the lambs are sold the settlement is made on the basis of the relative contribution of each signer of the contract. Lambs are weighed at the prevailing price for feeder lambs. Grain and hay are measured and valued on a similar basis. An allowance is made for man and horse labor and other items that are furnished by the feeder. Each party therefore furnishes a percentage of the total, and the other costs and proceeds from the sale of the lambs are divided on the basis of that percentage.

Contract feeding has been satisfactory to a limited extent, but is most widely followed in times of restricted credit facilities. In many cases it has not been satisfactory to either party. So long as owners and feeders possess characteristics commonly found in human beings, it is likely that there will be many cases of dispute and disagreement. In these cases it is customary for each party to the contract to choose a representative, and these two then choose a third to study the case and recommend a settlement. Contract feeding is not likely to be widely used over a very long period but is useful in conditions of little credit and low prices.

CHAPTER 34

Feed-lot Management and Rations for Fattening Lambs

Attributes of caretaker. To derive most profit from his effort, the lamb feeder must give consideration to many items and understand the influence of each. One of the least tangible of these matters is the attributes of the feeder. The degree to which he possesses and can exercise good judgment and skill is of great importance, for it is not unusual to see lambs, from the same band that arrived in the same shipment being fed the same kinds of feeds on neighboring farms, in which the response is far from the same. In the one case the feeder is quiet, observing, and careful. Many things which may contribute to the comfort of the lambs are done without much thought being given to them. Feeding is done regularly, quietly, the lambs are always supplied with good water, and the feed racks are clean. At feeding time the lambs are not frightened, ample feeding space is provided, and any lambs that may show indications of sickness are separated from the rest. The way the lambs are reacting to the feed is noticed, and adjustments are made so that difficulties are avoided. Feeders have available the same information, feeds, and other items, but, added to this, the one has "the eye of the master that fattens the cattle."

Feeding on arrival. Lambs should be handled carefully when they arrive from the range or market or when they are moved from one feeding area to another. Range lambs have been through a period of disturbance when they reach the feed lots or pastures. Most of them have been weaned shortly before shipment. This means excitement and a change in feeding. Many of them are trailed or trucked long distances to shipping points and are held without feed for rather long periods before loading and while en route. It is often uncomfortable for the lambs in the cars or trucks, and they are certain to be tired on arrival. Rest, water, and some

Courtesy Colorado A. and M. College

This is an extensive lamb-feeding enterprise in Colorado. Mistakes in any phase of such a business may be very costly.

palatable bulky feed are the things the lambs need at that time. Observation in many parts of the country shows that it is a good practice to restrict the lambs to good hay or not very succulent pasture for three or four days before they are turned onto the more succulent grazing or are started on grain. In fact, delaying grain feeding for some weeks and restricting the lambs to hay or pasture alone during that time is not unwise, especially if one wishes to feed the lambs for a rather long period. There are warnings from time to time that lambs should not be allowed to eat second or third cutting alfalfa hay as their first feed, but this is an unnecessary precaution if the hay is of high grade. In many areas of the West where lambs are fed, the first cutting of alfalfa is most like the second cutting in the Central States.

Care at this time will eliminate many difficulties later. After the lambs are thoroughly rested and have had several days on roughage or the right kind of pasture, grain feeding may be started. Whatever grains are fed, the amounts should be limited. Haste at this time results in difficulty later. Many feeders use oats to start lambs on feed, as lambs like them, and since they are relatively bulky, there is no great danger from their use. A quarter to not more than a half a pound per head is sufficient for the first few

days. At the end of two or three weeks the grain may have been increased to about a pound daily, and in most cases the amount fed when the lambs are on full feed will not exceed 1.50 or 1.75 pounds per lamb daily. Throughout the entire feeding period the lambs should have all the roughage they will eat in addition to the amount of grain they are allowed.

Starting on grain. It is not necessary to use any special feed such as oats to start lambs on feed, as they may be started on the ration which they are to receive during the full feeding period. Whatever feeds are used the above precautions should be observed. The only exception seems to be in the case of soybean or similar oil meal. Healthy lambs may be fed from one-half to one pound or more of soybean oil meal daily when they are being started on feed. After a few days a limited amount of corn or other grain may be added to the meal, and later, as further increases in the grain are made, the amount of meal is reduced accordingly. Since the meal is not especially satisfactory for fattening purposes when used in large amounts, there is no reason for extending its use beyond three or four weeks unless it is used in some way such as is described later in connection with corn silage.

When is a lamb on full feed? How much grain constitutes a full feed? These are questions that are frequently heard. Some contend that lambs will eat as much as two pounds of grain before they are on what is considered an amount of feed that will fatten them in a short time. Others, especially those who have large amounts of roughage which they wish the lambs to eat, believe the lambs are on a full feed when they are eating approximately a pound of grain. The latter feeders are not especially concerned about a short feeding period. While it is not insisted that the lambs would not eat more grain or that more could not be fed with safety, so far as the feeding program for the enterprise they are conducting is concerned, the lambs are on full feed. There is no disputing the fact that heavy grain feeding causes more digestive troubles than occur when grain is fed in limited amounts. Since digestive troubles are the cause of some death losses, the limited feeding program is certain to be the safest. Overeating on grain is a proved cause of many deaths in feed lots. This is one of the troublesome matters in field feeding.

Feeding schedule. For the safest feeding six weeks should be used to get lambs on a full feed of a ration such as corn and alfalfa

hay. For each 100 lambs the general feeding program may be as outlined in the tabulation, although heavy lambs may be fed more and very light lambs less than the quantities suggested.

TABLE 41

FEEDING SCHEDULE FOR 100 LAMBS

Number of days on feed	Shelled corn	Alfalfa hay
	lbs.	*lbs.*
1 to 7	25	Full feed—200
8 to 14	50	Full feed—200
15 to 21	75	Full feed—200
22 to 28	100	Full feed 175–200
29 to 100	100–175	Full feed 125–200

If the lambs are continued on a relatively light feed, the amount of corn will not be increased beyond a pound daily for each lamb, and they will eat relatively large amounts of hay. If the grain is increased so they receive a heavy grain allowance, the consumption of hay will be decreased, but lambs cannot be safely fed on less than a pound or one and a quarter pounds of roughage daily. When roughages such as corn silage or some of the sorghums that contain large amounts of grain are fed, some allowance should be made in the grain ration for this concentrate. The grain in such roughages may vary from nothing to almost 50 per cent of the total weight.

In case some protein-rich concentrate is fed with the grain and hay, it may be fed at a constant rate of 0.15 to 0.25 pound daily per lamb for the entire feeding period, or it may be fed as a definite percentage of the grain. A proportion of one pound of protein meal to seven pounds of corn is generally used in the latter case.

Self-feeding schedule. One of the easiest ways to get lambs on feed is the use of a self-feeder. If the grains are ground and roughages are ground or chopped and the two are mixed in the proper proportions, lambs may be given a relatively heavy feeding of grain early in the feeding period. This is one of the reasons why those who desire to finish lambs in a very short time place much reliance on this method of feeding. At the Illinois Station 100 pounds of ground corn and 300 pounds of ground or finely chopped alfalfa hay have been mixed and fed to lambs at the start of the feeding. The mixture is sufficiently bulky to be fed to the full

capacity of the lambs. If lambs eat two and one-half or three pounds of the mixture daily at the start of the period, they are consuming from 0.6 to 0.75 pound of grain. This is more than can be safely fed when hand-feeding is followed and the grain and hay are fed separately. The proportion of grain to hay may be changed so that at the end of three weeks the lambs may be eating a mixture of 100 pounds of grain and 100 pounds of roughage. Although the proportion of grain may be further increased, most feeders will not gain much thereby unless there is a situation where the cost of hay is very high in relation to the price of grain.

Manner of feeding. Feeding regularly and twice daily is the general practice, although a few feed three times daily. There is no apparent advantage to three feedings compared with two. The grain portion of the ration is fed in equal amounts and is usually fed before hay. It is advisable to have the lots arranged so the grain may be placed in the troughs while the lambs are confined away from the racks. This permits easy cleaning and gives all the lambs a more equal chance to get their share of the ration. If combination grain and hay racks are used, the grain and hay may be placed in the racks together before the lambs are turned in. If silage is fed it may be placed in the rack first and then the grain spread over it and the hay fed later, or it may be placed in a separate part of the rack if racks of that type are used.

Length of period. The length of the feeding period is a matter that is largely under the control of the feeder, although it is influenced by the weight and condition of the lambs at the start. It is also influenced by the kinds of feeds used and the method of feeding. A more or less standard feeding period for lambs that weigh from 60 to 65 pounds is 90 to 120 days, but it is possible to shorten this if the lambs are heavily fed; and it is possible to extend it by withholding concentrates for a part of the time or by feeding them in reduced quantities for the entire time. Usually, a feeding period in which fast gains are obtained is the most economical with respect to the amount of feed required for the gains, but this may not always be the most profitable plan because of fluctuations in prices. Some feeders choose a long feeding period because they wish to have the lambs ready for market at a certain time, and they buy the lambs considerably ahead because of price considerations and availability of lambs. They may also wish to have the lambs "clean up fields and put some cheap roughages through them."

If many lambs are fed, some may be sorted out and marketed in 45 to 60 days because they were much fatter than others at the start, and it takes relatively little feed to put them in market condition. These are matters where the judgment of the feeder is of much consequence. Since gains late in the feeding period after the lambs are nearly finished are expensive and slow, it is not often profitable to hold them beyond that point in an effort to "hit a high spot in the market."

Influence of sex. Feeder lambs from the ranges are generally mixed ewe and wether lambs, especially if they are black-faced lambs. There are some "straight" loads of wether lambs among white-faced lambs as many ewe lambs of that kind are retained for breeding purposes. On the basis of studies at the Illinois Station [1] it was found that there was little difference in the feed consumption of ewe and wether lambs, but the wether lambs showed a slight advantage in the matter of rate of gain. The ewe lambs were credited with slightly better finish, and they also showed a very slight superiority in the matter of dressing percentage. This may have been due to their better quality and greater smoothness of form. There was nothing in the behavior of the ewe or the wether lambs to make the feeder or the packer prefer one over the other. However, in an analysis of data from Colorado [2] tests it was found that there was a significant difference in the rate of gain made by 209 wether lambs compared with the gains of 83 ewe lambs and that this difference was in favor of the wether lambs. It is unlikely that sufficient trials with the specific object of comparing lambs on the basis of the influence of sex have been conducted to settle the question, and until this has been done it will remain to some extent a matter of opinion.

As lambs mature the differences between the sexes become more pronounced, and after passing out of the lamb class ewes and wethers are sold separately. Wethers sell for more than ewes because they are expected to dress a higher percentage.

Shearing. A practice about which there is much discussion by lamb feeders is the matter of shearing. It is most widely advocated when wool prices are high, or there is likelihood that they will advance. Some people have the mistaken idea that they will be ahead the value of the wool, as the lambs will be just as valuable for

---

[1] Ill. Exp. Sta. Bul. 167.

[2] Colo. Tech. Bul. 10.

meat without the wool as with it. It is of course true that the amount of meat obtained will be the same in either case. But the lamb with its fleece is of more value to the purchaser than the shorn lamb because of the pelt credit. The chief value of the pelt comes from the wool, and if lambs have been recently shorn the only pelt credit allowed by the butcher is for the skin, which is far less valuable than the wool. Pelts are valued according to the length of wool carried. A full-fleeced skin is most valuable. A number 1 pelt, wool length 3/4 to 1 inch, can be produced in eight to twelve weeks after shearing. Four to eight weeks is sufficient time to produce a number 2 pelt with wool from 1/2 to 3/4 inch long. Number 3 pelts carry from 1/4 to 1/2 inch of wool and can be produced in about four weeks after shearing. The time required is of course dependent to some extent upon the type of lamb and the closeness of shearing. If the fleece, worth several dollars, is removed from the lamb, the price paid per hundredweight for the lamb will reflect this lowered value. Hence, whether lambs should be sheared before they are marketed or be sold in full fleece will depend upon these factors: the relative prices of shorn and unshorn lambs, the price of wool, the amount that the lambs may shear, and the cost of shearing and marketing the wool.

The other phase of this matter is the effect that shearing may have on the rate and economy of gains. It is sometimes advocated for lambs that are fed in the late summer and fall months, and especially for lambs when the feeding period extends into the spring when the days are warm. It is also suggested as a means of getting rid of many ticks if the lambs have not been dipped. Shorn lambs will generally have better appetites, especially during warm weather, and hence they may be expected to do better than if left in the wool. At other times, however, the effects of shearing may not be entirely favorable. Without adequate shelter newly shorn lambs may become chilled during cold, stormy weather. While they may display better appetites, experimental work has not confirmed the opinion that shorn lambs gain faster and do so with greater economy. When two lots of lambs are observed, it always seems that the shorn group is doing much better, as they look fresher and cleaner. But there is little data that show any advantage with respect to the use of feed. In a Michigan test where the lambs were well protected at all times, shorn lambs ate 0.1 pound more of grain and 0.2 pound more of hay per head daily but made 30 per cent less gain than

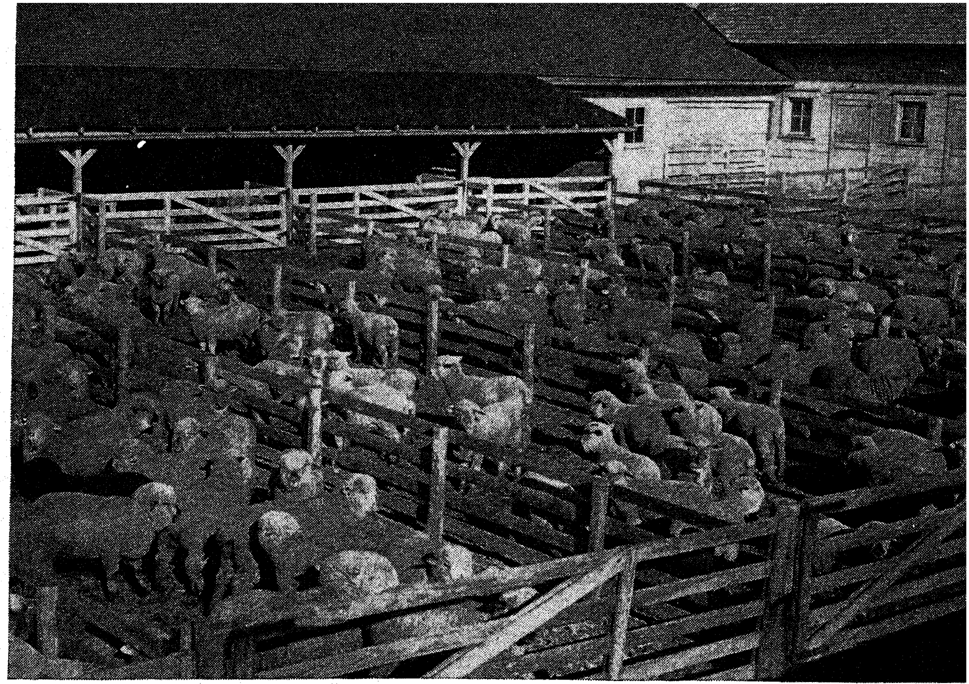
unshorn lambs. In Nebraska [1] the gain was slightly greater and the cost less for shorn lambs, but they were less profitable because of the discrimination in price when sold. In other Nebraska tests [2] lambs sheared ten days after starting on feed made less gains and required more feed per 100 pounds gain but had a higher dressing percentage than those not shorn. The removal of the fleece would account for an increased dressing percentage.

At Purdue [3] lambs shorn in March and fed for 60 days gained 0.50 pound, and unshorn lambs gained 0.49 pound daily. There were equally small differences in other respects. In another test the Purdue Station [4] found that lambs shorn in November and fed until the next March had keener appetites and were more active, but they did not consume any more feed than unshorn lambs. The wooled lambs gained 0.30 pound daily compared with 0.28 pound for the sheared ones. The cost of gains was lower and the profit greater for the wooled lambs. Purdue also reported a trial [5] in which lambs were shorn in January two weeks before they were marketed. For the entire 90-day feeding period the shorn lambs made only 85 per cent as much gain as the lambs that carried their fleeces the full time, and the feed requirement per hundredweight gain was 464 pounds of concentrates and 897 pounds of roughage for the former and but 393 pounds of concentrates and 776 pounds of roughage for the latter.

In a 78-day test beginning October 11, the Minnesota Station [6] found little difference in shorn and unshorn lambs. The shorn lambs required 13 pounds less hay but 16 pounds more grain for a hundred pounds of gain than wooled lambs. The average daily gain was 0.30 for the former and 0.29 pound for the lambs in full fleece.

A recent test at the Illinois Station [7] failed to show anything in favor of shearing lambs fed during the fall and winter. A group of shorn and a group of wooled lambs were fed the same rations but not in exactly the same amounts. The test covered 84 days beginning in late October.

[1] Neb. Bul. 170.
[2] Neb. Bul. 204.
[3] Purdue Bul. 168.
[4] Purdue Bul. 202.
[5] Purdue Bul. 221.
[6] Minn. 1943 Mimeo. Rpt.
[7] Ill. Agr. Exp. Sta. Mimeo. Project 338.



Courtesy University of Illinois

In feeding tests, lots of shorn lambs did not surpass comparable lots of full-fleeced lambs in rate or economy of gains.

TABLE 42

COMPARISON OF SHORN AND UNSHORN LAMBS

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Number of lambs	40	41	40	41	42	42
Fleece condition	Unshorn	Shorn	Unshorn	Shorn	Unshorn	Shorn
Average daily gain, lbs.	0.38	0.37	0.40	0.39	0.43	0.40
Feet per cwt. gain, lbs.						
Corn	299	306	257	262	198	212
Soybean oil meal	42	44	64	66	99	106
Corn silage	852	941	839	932	834	918

Another test [1] a year later confirmed the results summarized above.

Shelter. The need for shelter varies widely in different areas. There is no particular need for shelter from the standpoint of warmth in most sections, but in many places shelters do contribute to the convenience in feeding and to the saving of manure. Lambs appear very uncomfortable and are certainly not attractive to handle when wet. They are also subject to chilling when wet, but

[1] Ill. Agr. Exp. Sta. Mimeo. Project 339.

if they have dense fleeces it requires considerable rain to penetrate to the skin. Where relatively dry conditions prevail, shelter may pay a fair return on the investment but nothing beyond that. The Oregon Station [1] during a three-year period secured the following results:

TABLE 43

OPEN LOT COMPARED WITH SHELTER FOR FATTENING LAMBS

Number of lambs	Lot	Average daily gain	Feed per cwt. gain, lbs.	
			Grain	Hay
		lbs.		
404	Open	0.29	290	945
403	Shed	0.30	279	914

The lambs that had access to the shelter made use of it during wet, stormy weather, but they were indifferent to the cold, dry weather.

In studies of the type of shelter Purdue [2] reported that lambs fed in an open shed returned larger profits than those that were fed in a well-ventilated barn. This was true whether the lambs were shorn or in full fleece. The barn-fed lambs were not allowed outside at any time, but the shed-fed lots had access at all times to a small adjoining lot. The feed consumption, feed requirement per unit of gain, and the rate of gain were not always in favor of the open shed and the differences were relatively small in all cases.

Exercise. Lambs that are fed in restricted quarters gain better than if they are allowed a large territory to wander over. The differences are small however, and lambs that are fed on pastures, wheat fields, and in corn or beet fields make good gains, although they may walk a considerable distance each day. Extreme confinement is practiced at some of the highly specialized feeding plants. Most farm feeders provide a yard or lot for the lambs.

Bedding. Bedding is used to a considerable extent by some feeders as they believe in keeping the lambs as clean as possible, and the use of bedding materials is helpful in saving the fertilizing value of the feces and of the urine. Others use no bedding materials of any kind except the small amount of refused roughages when these are rather liberally fed. The need for bedding will depend to

[1] Ore. Bul. 175.

[2] Purdue Buls. 168, 179, 184, 192, 202.

some extent upon the climate and upon the kind of ration fed. In feeding large amounts of protein concentrates and succulent feed such as silage, it will require far more bedding to keep the pens dry than if these concentrates are fed in small amounts and the roughage is only hay and straw. If there is good protection from the weather and if a great many lambs are not confined to a very small area, bedding once weekly is generally sufficient.

Hand- vs. self-feeding. Self-feeding has been used for a number of years at large feeding plants, especially where screenings were fed, and it was the aim to finish the lambs as quickly as possible. Heavier grains were generally mixed with screenings to lighten the ration. Often too, some molasses was mixed with the other parts of the ration to improve its palatability to the lambs. Hay was generally fed in separate racks. Little self-feeding was done on farms until machinery was available to enable the farmer to prepare a ration that could be self-fed with a high degree of safety. This has been done by grinding the grains and mixing them with roughage that was also ground or cut. In this way the lambs were prevented from overeating on grains because of the bulkiness of the ration. In general, it is unsafe to self-feed lambs on grains fed separately without something being added to provide the bulk needed by them. Although there are instances where lambs have been self-fed on shelled corn and uncut hay placed in separate feeders, the practice is not one that many feeders follow or consider safe.

A number of comparisons have been made of hand-feeding and self-feeding. Most of these trials show the self-fed lambs make larger daily gains and thus attain a higher finish in a given time. This is one of the main advantages of the use of the self-feeder. These comparisons also show that the feed required for a hundred pounds of gain is usually a little greater with self-feeding. There is some saving in labor with self-feeding so far as the feeding operation is concerned, but this is offset to a considerable extent in many cases because of the time required to process and mix the feeds. Besides, it is necessary to give the feeders regular attention to be certain that the mixture is working down and is available to the lambs. Feed-processing machines must be bought, and self-feeders are more expensive to build than the bunks and troughs usually used for hand-feeding, but the number needed for a given number of lambs is considerably less. A well-made feeder 12 feet long, from

which the lambs may eat from both sides, is large enough for from 50 to 100 lambs. Unless self-feeders are very carefully made so the feed will not become wet during rains, they are not suitable for outdoor use. If feed becomes soiled in the sections from which the lambs eat, they will not consume feed to their capacity, with the result that gains are reduced. The feeders must be kept cleaned. Very finely ground feeds are not relished by lambs, and for self-feeding the grinding should be no finer than is necessary to keep the lambs from picking the grain from the mixture. It is also important not to use a mixture made of a large proportion of grain. Equal amounts of grain and hay are satisfactory when the lambs are on full feed. If mixtures of more than 60 per cent grain and less than 40 per cent hay are used, some additional hay should be fed to provide bulk. Feeding is simplified if only the self-feeders are used. For the first week the mixture should contain 75 per cent of roughage with gradual reductions until, after about three weeks, equal amounts of grain and roughage are used. With careful feeding there is little or no waste of feed.

The use of corn and alfalfa hay hand-fed and self-fed yielded the following data at two experiment stations.[1]

TABLE 44

HAND-FEEDING AND SELF-FEEDING COMPARISONS

Rations: Hand-fed: Shelled corn, alfalfa hay; Self-fed: Ground corn, ground or cut alfalfa hay

Days fed	Method	Feed eaten daily, lbs.		Average daily gain	Feed per 100 pounds gain, lbs.	
		Grain	Hay		Grain	Hay
				lbs.		
80	Hand	1.10	1.52	0.32	342	474
80	Self	1.44	1.90	0.39	373	496
85	Hand	1.17	1.65	0.38	309	436
85	Self	1.26	1.82	0.43	295	428
80	Hand	1.21	1.52	0.31	390	463
80	Self	1.56	1.96	0.36	415	525
85	Hand	1.55	1.31	0.40	387	327
85	Self	1.80	1.52 [a]	0.48	375	318 [a]

[a] A small amount of whole alfalfa hay was fed early in the feeding.

[1] The first six trials from Illinois Station Circular 523. The last two from Minnesota Station Bulletin 306.

A ration of a single grain and a roughage is the simplest that can be self-fed. More complex mixtures are possible, and it is not unusual for feeders to add a protein concentrate to the corn and hay. The following data from the Minnesota Station[1] illustrate this practice.

TABLE 45

HAND-FEEDING A RATION COMPARED WITH VARIOUS PROPORTIONS OF THE SAME RATION SELF-FED

Days fed	Method	Feed eaten daily, lbs.		Average daily gain	Feed per 100 pounds gain, lbs.	
		Concentrates	Hay		Concentrates	Hay
				lbs.		
77	Hand	1.67	1.02	0.33	497	303
77	Hand	1.67	1.02	0.38	432	264
77	Self	1.62	1.55	0.37	411	418
77	Self	1.73	1.33	0.42	417	319
75	Hand	1.65	1.30	0.43	387	305
75	Hand	1.65	1.30	0.42	389	306
75	Self	1.56	1.56	0.47	334	334
75	Self	1.97	1.37	0.52	380	265

The first hand-fed group in each case was fed on whole alfalfa hay, and the second groups were fed cut alfalfa hay. The first self-fed lots in both the 77- and 75-day tests were fed 50 per cent concentrates and 50 per cent cut hay; the other two self-fed lots received a mixture of 60 per cent concentrates and 40 per cent hay. In all of these groups the concentrates consisted of 90 per cent corn and 10 per cent linseed oil meal.

Many other rations may be self-fed. Those which are superior when hand-fed may be expected to be superior when self-fed.

Rations for fattening lambs. In experimental work pertaining to lamb feeding there have been many comparisons of rations. To obtain a thorough and wide acquaintance with all of this work, the student will find it necessary to consult the reports of such investigations. For the purposes of summary in this text, no effort is made to list all of the comparisons that have been made. With a reasonable knowledge of the characteristics of feeds and of the requirements of lambs, it is possible for anyone to formulate satisfactory rations. In practical feeding operations the relative unit prices

[1] Minn. Bul. 306.

of different feeds is always an important consideration. Rations may consist of only one or two feeds or of complex mixtures of 10 or 15 feeds together with concoctions of many minerals and drugs. For most purposes lamb-fattening rations may be grouped into the following general classes. Such grouping is advisable, as it is the best means of organizing the multitude of reports pertaining to tests of rations. If desired, additional listings may be made under each of the groups.

1. Roughage or pasture
2. Grain with roughage
3. Grain and supplement with roughage
4. Miscellaneous

In this grouping no distinction is made with respect to dry roughages such as hays, straws, and fodders, and succulent roughages such as silages. In the case of supplements the grouping includes all materials, such as mill feeds purchased for use with farm grains and roughages. A miscellaneous group is necessary because of the use that is made of materials such as cull beans, potatoes, cannery materials, and other by-products.

For the most part the value of these rations will be closely related to the chemical composition of the feeds, the digestibility of the nutrients, how well the needs of the lambs are met, the palatability of the ration, and the amounts in which consumed. Any feed that is low in nutrient content will not have a high value in the ration. If high in nutrients but disliked by the lambs, its value will be low. If the ration is high in its content of some nutrients but lacking in others, its value will be low. To be of high value the ration must be liked by the lambs, and it must meet their needs in both its chemical and physical features.

Pasture or roughage feeding. Although pasture is not often thought of as a ration, the simplest rations for feeding lambs are composed of pasture, hay, or other roughage alone. Is it possible to fatten lambs when they are fed on these things? If they cannot be fattened will they gain in weight?

Thousands of lambs are fed on pastures. Their response to such feeding is closely related to the kinds of pastures used. Ladino clover is reported to be one of the best pastures in many of the irrigated areas of the western states. It has done well too in all comparisons with other pastures that have been reported from the Corn Belt and eastern sections. In some areas Korean lespedeza and other

legumes are used extensively. At the Illinois Station lespedeza pasture resulted in a gain of 15 pounds per head in a 49-day period. Alfalfa pasture, like most of the legumes, is productive of good gains. After these crops are frosted, lambs will not gain well on them. As feeds to be used alone for lambs, these crops as growing pastures are much better than when used as hays. Lambs will not fatten on grass pastures, although they may make some gain in weight. To fatten lambs on grass pastures requires the use of grain, but there are some lambs that have had no grain that are sold directly off legume pastures as fat lambs. To accomplish this requires that everything be favorable and the pasture abundant and succulent.

The wheat fields constitute one of the most extensive pasture-feeding areas. With reasonably favorable conditions many lambs fatten on such pastures without grain.

There is no hay that is superior to alfalfa so we would expect lambs to fatten on it if they can be fattened on any kind of hay. The Oregon Station [1] reported that "feeding alfalfa hay alone without

TABLE 46

LEGUME HAYS OR CORN SILAGE ALONE FOR LAMBS

Source of data [2]	Kind of hay	Days fed	Daily amount	Amount per cwt. gain	Daily gain
			lbs.	*lbs.*	*lbs.*
Oregon	Alfalfa	50	2.6	3,710	0.07
Oregon	Alfalfa	75	2.7	4,500	0.06
Oregon	Alfalfa	100	2.6	5,200	0.05
Oregon	Alfalfa	90	2.3	5,750	0.04
Nevada	Alfalfa	70	3.0	1,743	0.17
Illinois	Alfalfa	56	2.4	2,179	0.11
Illinois	Lespedeza	56	2.5	2,027	0.12
Illinois	Corn silage [a]	56	4.4	3,440	0.13
Purdue [b]	Clover hay	90	1.9	6,451	0.03
	Corn silage	90	1.1	3,811	0.03
Nebraska [b]	Alfalfa	92	—	4,190	0.10

[a] Plus 0.2 pound soybean oil meal and 0.02 pound limestone daily.
[b] Average of three tests.

[1] Ore. Agr. Exp. Sta. Bul. 218.
[2] Ore. Agr. Exp. Sta. Bul. 218.
Ill. Mimeo. Projects.
Nevada Agr. Exp. Sta. Bul. 106.
Neb. Agr. Exp. Sta. Bul. 194.
Purdue Agr. Exp. Sta. Bul. 360.

grain just keeps lambs growing nicely—they will not fatten." The same results were reported by several other stations. Other legume hays would excel grass hays, and the latter fed without any grain would probably not result in any gain of consequence.

Since good rations will produce gains of 0.3 and 0.4 pound daily, the use of roughage alone could not be considered advisable except for the purpose of delaying the time of marketing. In such cases grain would be used during the latter part of the feeding period to finish the lambs, and the low rate of gain earlier would therefore not be of much concern.

Grains and roughage or pasture. Obviously, if roughage alone will not fatten lambs and since they cannot be fed on concentrates entirely, a ration of both concentrates and roughage would be the logical choice. Since corn is the great fattening grain and alfalfa the most extensively used hay for lambs, a ration of corn and alfalfa may be taken as a standard with which other rations may be compared. Furthermore, with this as a basic ration, it is easy to make substitutions and additions, and knowing the characteristics of feeds and how they compare with corn and with alfalfa hay, it is not difficult to get an understanding of how lambs respond to various rations.

Corn and alfalfa hay may be expected to fatten feeder lambs in from 90 to 110 days. The average daily gain may be expected to be one pound every three days or 0.33 pound daily. An average for fifteen different lots of lambs fed at the Illinois Station shows that they ate 1.16 pounds of corn and 1.44 pounds of alfalfa hay daily and gained 0.32 pound. The feed requirement for 100 pounds of gain was 366 pounds of corn and 440 pounds of hay.

It is of course possible to vary the proportions in which the corn and hay are fed. For safe feeding in the Corn Belt areas it is usual to limit the corn to one pound for each pound of hay. In areas where hay is plentiful and relatively cheap in comparison with corn, the corn may be fed at a proportion of about one pound to two pounds of hay. This will reduce the rate of gain and lengthen the time required to fatten the lambs, and the corn per 100 pounds of gain will be lessened, but the hay will be greatly increased. When the reverse is practiced, that is, a large amount of corn fed in proportion to hay, there is more likelihood of lambs overeating and developing digestive troubles. In no case is it advisable to feed corn and hay in a ratio of more than 2 to 1; and in most it will be in-

advisable to feed a ratio of more than 1.5 to 1. When these larger amounts of corn are fed to the limit of the lambs' capacity without their going "off feed," the gains will be rapid and the feeding period shortened. Gains may amount to 0.4 pound or more daily for a period of 60 or 70 days. In feed requirement for each unit of gain the corn will be high and the hay reduced, compared with the proportion of 1 to 1. The following results from the Illinois Station have been substantiated by others.

TABLE 47

PROPORTIONS OF CORN AND HAY FOR FATTENING LAMBS[1]

Approximate proportion of corn to hay	Daily feed, lbs.		Average daily gain	Feed per 100 pounds gain	
	Corn	Hay		Corn	Hay
			lbs.	*lbs.*	*lbs.*
1 to 1	1.30	1.20	0.32	412	380
1 to 1.3	1.09	1.45	0.30	373	497
1 to 2.2	.80	1.75	0.25	313	698

The student of lamb feeding should not fail to relate how this operation conforms to other recommendations for sound farming practices. Corn and alfalfa are high-yielding and high-profit crops in much of the highly productive lamb-feeding area of this country. Because of this the use of this combination of feeds is one which is in no way contradictory to good farming methods. Where corn cannot be grown because of climatic conditions or where soil conditions and crop rotations make other legumes advisable, the effort of the feeder is to find rations that are equally good. Even where corn and alfalfa are grown, other feeds are also available, and relative prices and results are important in deciding whether to modify the ration. Indeed, there are many who wish a more productive ration than corn and alfalfa hay, and efforts toward its improvement through the addition of other materials to these two basic feeds have been many. There have been so many reports regarding some phases of the problem that it is difficult to harmonize the results obtained by one investigator with those of another. Where detailed information is wanted regarding a certain test with any combination of feeds, it will be necessary to consult original reports, as summary statements are all that can be given here.

[1] Average of two trials of 90 and 98 days. Ill. Agr. Exp. Sta. Bul. 167.

If it is assumed that corn and alfalfa hay constitute a standard ration for fattening lambs and that other rations are compared with it, then it is logical to state that the relative value of any other ration will depend upon its digestible nutrient content, upon the relationship of nutrients to the lamb's requirements, and upon the amount eaten. In this statement it is assumed that nutrient content pertains to all nutrients rather than the usual totally digestible nutrients. In general, such a balance of nutrients as found in a ration of corn and alfalfa hay is a close approximation of what is required by lambs. Hence, any superiority of another ration is likely to be due to a considerable extent to a greater intake of feed nutrients. If the nutrient intake is limited to the same amounts in the two cases, and there is a difference in the response of the lambs, such a difference may then be assumed to be due to a difference in digestibility or in the value of the nutrients. Students of lamb feeding often fail to recognize the importance of equal nutrient intake in such comparisons. Much of the difference in rations is due to differences in nutrient consumption, which is associated with the palatability of the rations. This is of course a practical consideration of consequence, but it is an explanation of ration differences on quite another basis, than that the nutrients of one are superior to the nutrients of another.

Replacing corn. One of the most frequent departures from a corn and alfalfa ration is the use of some other grain as a partial or complete replacement of corn. The use of barley, wheat, rye, oats, and sorghums is common. The following summarizes results from such feeds with alfalfa hay. The same feeding schedule suggested, in Table 41 on page 364, for corn is a suitable guide to use for the other grains also.

Barley. Barley is used most extensively in the northern and western areas, where it can be more successfully grown than corn. It is relatively low in protein, although it is somewhat higher in this respect than corn, but since its digestible nutrient content is lower than that of corn, it has a lower value. Numerous comparisons have been made of the two grains at experiment stations. While there is some variation in the results, barley is worth about 85 to 90 per cent as much per pound as corn. An average of most of the experimental comparisons show barley 87 per cent as valuable as corn. This value is the same whether the grains are fed alone or whether a protein concentrate is used in addition. In the

calculation of this value, the slightly greater gain from the use of corn is disregarded. Corn has produced 3 per cent faster gain, and barley-fed lambs take a little longer feeding period to attain the same finish as others fed corn. Hence, when barley can be obtained for less than 85 per cent of the cost of corn per hundredweight, it is advisable to use it.

In general, too, barley has the same value fed alone as when fed as a part of a ration along with corn or other grain. Barley damaged by scab or other diseases has given good results when fed to lambs, but since the extent of damage varies greatly, disease-injured grains should not be considered equal to sound grain.

Wheat. Wheat may be used for feeding fattening lambs, but it is not the equal of corn. In some cases it has been inferior to barley, but for the most part is considered to have a higher value than barley. Some whole wheat may pass undigested through lambs. This is a condition that is seldom found with other grains, although rye is also unmasticated in some instances. Grinding to overcome this is not advised, as lambs do not eat ground wheat so readily as the whole grain, and the gains are lowered and are less economical in feed required per unit of gain. Some cases of bloat are reported when whole wheat is the only grain fed. Ground wheat or mixtures of wheat and other grains do not seem to affect lambs in this way. It is frequently advised that it be fed as a part of the grain ration along with corn or other grain, as better results may be secured, and there is less trouble from lambs going "off feed."

According to some tests,[1] Table 48 on page 380, from 7 to 10 per cent more grain and hay are required for a unit of gain when whole wheat is used in place of corn.

Rye. Rye has approximately the same feeding value as wheat. It is not very palatable either whole or ground and is easiest to feed when used with some other grain, especially corn or oats. Some caution is advisable to avoid rye that contains much ergot.

Oats. Oats are one of the most palatable grains and can be used to advantage in starting lambs on feed and as a partial substitute for corn during the first half or more of the feeding period. They are one of the safest grains because of their bulk, and their use results in a reduced consumption of roughage. As a complete substitute in the ration for corn, oats are usually not worth more than 75 per cent as much per pound as corn; sometimes their value

[1] Ill. Agr. Exp. Sta. Cir. 523. Neb. Buls. 256–257. Okla. Bul. 213. Idaho Bul. 194.

TABLE 48

Some Comparisons of Whole Wheat, Shelled Corn, and Barley for Lambs

Station	Days fed	Grain	Average Amounts of Feed Daily, lbs.		Average Daily Gain	Feed per 100 Pounds Gain, lbs.	
			Grain	Alfalfa		Grain	Alfalfa
					lbs.		
Illinois..........	57	Wheat	1.33	1.68	0.32	418	529
		Corn	1.34	1.69	0.34	389	490
Nebraska........	115	Wheat	1.06	1.39	0.23	457	602
		Corn	1.06	1.39	0.25	419	552
Nebraska........	84	Wheat	1.12	1.38	0.29	389	482
		Corn	1.12	1.38	0.32	352	435
Oklahoma.......	104	Wheat	1.30	1.30	0.33	392	392
		Corn	1.16	1.36	0.31	366	431
Idaho...........	122	Wheat	1.08	2.47	0.30	356	811
		Barley	1.13	2.60	0.30	366	840

is considerably less, and in only a few cases has it been more. Gains are not likely to be so rapid nor the finish so good, and the cost with the usual price relationship between oats and corn is apt to be more expensive with oats.

Sorghums. Grains of the sorghums may be substituted for corn in the ration, and since they are not greatly different in digestible nutrient content, similar results will be obtained. This is true whether the grains are fed whole, ground, threshed, or unthreshed, so long as the amounts of grain eaten are the same; and there is no particular value to their use in one form compared with another, aside from such considerations as storage, ease of handling, and so on.

Replacing alfalfa. Instead of alfalfa hay, other legume or nonlegume hays are fed. With hays of equal quality, rations of equal value may be made through the use of red clover, annual lespedeza, or soybean hays. The two former are equal but apparently not superior to alfalfa per ton. Soybean hay will produce the same results as alfalfa, but a larger amount must be fed because of the waste due to the coarse stems of the soybean hay. In tests at Illinois it required approximately 1.2 tons of soybean hay to replace a ton of alfalfa. The same is true with respect to sweet clover hay.

Of course if a poor quality of soybean or sweet clover hay is compared with alfalfa hay of high quality, the relative values may be much different. In some instances one legume hay is only 50 per cent as valuable as another because of differences in quality. Thus, the man who produces his own feeds for lamb feeding has many considerations to keep in mind. These include such matters as costs of production, yield per acre, ease of curing, storing, and so forth.

TABLE 49

RATIONS OF CORN AND LEGUME HAYS FOR FATTENING LAMBS

STATION	HAY	AVERAGE AMOUNTS OF FEED DAILY, LBS.		AVERAGE DAILY GAIN	FEED PER 100 POUNDS OF GAIN, LBS.	
		Corn	Hay		Corn	Hay
				lbs.		
Illinois [a]	Alfalfa	1.14	1.61	0.31	368	519
	Lespedeza	1.19	1.64	0.31	387	545
Illinois [b]	Alfalfa	1.12	1.42	0.33	343	433 fed 407 eaten
	Soybean	1.11	1.69	0.33	333	507 fed 405 eaten
Ohio [c]	Clover	1.18	1.20	0.28	421	426
Purdue [d]	Clover	1.09	1.72	0.31	353	554

[a] Average of 3 trials.
[b] Average of 3 trials.
[c] Average of 4 trials.
[d] Average of 8 trials.

Other hays are often used instead of legumes. Timothy, prairie, and other grass hays are most commonly used. It is obvious from a consideration of the composition of these hays that they are much lower in some nutrients than the legume hays. It is these nutrients in which the grass hays are low that are needed to make good rations with the farm grains. Hence, they do not combine so well as legume hays and farm grains for lamb-fattening rations, and therefore have much lower values. Only through the use of additional supplementary feeds can farm grains and nonlegume hays be made into efficient rations for fattening purposes.

Grain, hay, and silage. These statements regarding nonlegume hays are true too of silages, except possibly those made from legumes. While corn silage, sorghum silage, and other silages may be used to good advantage in feeding lambs, they do not combine

well with farm grains alone. Thus, these materials are best used in more complex rations. In such rations they are very valuable.

Rations composed of grain, hay, and silage are not greatly different in some cases from rations of grain and hay. Of course the silage is succulent, but nonlegume hays and nonlegume silages are similar in their relatively low protein content. Likewise, the legume hays and legume silages would be similar in some respects, although there might also be considerable differences in them due to the effect of time of harvesting and the method of storage on the retention of their nutrient contents. A ration of grain, legume hay, and corn silage would be superior to one of the same grain, a nonlegume hay, and corn silage. All such rations as the latter are likely to be low in protein and perhaps also in calcium and would therefore be less satisfactory than rations of grain, supplement, hay, and silage, or of grain, legume hay, and silage. The chief value of silage in such rations is in the grain and hay that are saved rather than in an increased rate of gain and shortened feeding period.

Field-feeding results. In some types of field feeding, rations similar to grain and roughage combinations are often used. The "lambing down of corn" that is practiced to a considerable extent in parts of the Corn Belt is essentially such feeding. The amounts of all feeds provided at any one time is of course not controlled, but the kinds of feed available are controlled within limits. Thus, in order to give the lambs a ration comparable with a dry-lot ration of corn and alfalfa hay, the feeder may feed the lambs hay while they are harvesting the corn, or he may accomplish a similar result through the use of adjoining pastures or an inter-crop of soybeans, rape, rye, or wheat.

One of the difficulties of the field feeding of lambs is overeating on corn. The most practical method of reducing difficulties in this respect is through the use of palatable roughages. It is also good management to confine the lambs to a relatively small area of the field after they have consumed the field roughages. An area that provides about two bushels of corn for each lamb is suggested, as this is the approximate amount of corn required to fatten a feeder lamb of average weight and condition. The amount of harvested roughage for field feeding is small, as it need be supplied for only about half the feeding period, and lambs will eat from one-half to one pound daily during that time, as they gather additional roughage from the fields.

The following table shows a summary of some of the results secured in field feeding. Not all of the feeds used would conform with the type of ration now under consideration—grain and roughage or pasture—but most cornfield feeding is primarily based on such a ration.

TABLE 50

AVERAGE DAILY GAINS IN POUNDS BY LAMBS FED IN CORNFIELDS

	Station			
	Illinois	Nebraska	Ohio	Purdue
Cornfield alone	0.10	—	0.15	0.08
Cornfield and adjoining pasture	0.32 [a]			
	0.31 [b]	0.27 [c]	0.21 [d]	—
Cornfield and soybeans, legume hay	0.29 [e]	—	0.29	0.23
Cornfield, legume hay	0.34 [f]	—	0.30	—
Cornfield, protein concentrate	—	—	0.27	—
Cornfield, protein concentrate, legume hay	—	0.36	0.35	—

[a] Alfalfa pasture for 49 days, alfalfa hay next 31 days
[b] Mixed clover and timothy pasture 55 days, alfalfa hay 25 days
[c] Bluegrass pasture and 0.25 pound linseed oil meal per day
[d] Bluegrass pasture
[e] Soybeans in cornfield 28 days, soybean hay 67 days
[f] Cornfield alone 28 days; alfalfa hay 67 days

Grain, supplement, and roughage. One of the most frequent ways in which a ration of a grain and a hay is modified is through the use of a protein concentrate, either as an addition to the ration or as a replacement of a part of the grain. Thus a protein concentrate may be used in two very dissimilar ways. In either case the protein content of the ration will be affected, and it may be that palatability and other factors are also modified. If the protein concentrate is used as an addition to the ration and more feed is fed daily per lamb, it is logical to expect an increased rate of gain and a higher degree of finish in a certain period. Whether this will be profitable depends upon the relative prices of grains and hay and the protein supplement. If the use of the supplement reduces the amounts of the other feeds required per unit of gain so that the cost of the feed saved is equal to the cost of the supplement used to replace them, the use of the supplement will just pay for itself. If the supplement results in the lambs bringing a higher price because of a higher finish, there may be some profit in its use. Since the price relationships vary considerably, the use of a protein con-

centrate with a ration of grain and a legume hay is a matter that must be decided for each feeding period.

A protein supplement should always be used with such rations as a grain and grass hay or with grain and silage, with the exception of silages from legumes. It is only through the use of the supplement that such rations will provide sufficient amounts of protein and be sufficiently palatable for the lambs to make satisfactory gains. In such cases the protein concentrate will have a high value; whereas, when used with a grain and legume ration, such as corn and alfalfa hay, a ton of protein meal may not have a value of more than 40 bushels of corn and a half ton of hay. In the latter case it is not necessary to use the supplement to properly nourish the lambs, but this is a necessary result with nonlegume hay or silage.

A calcium supplement further increases the value of the ration composed of nonlegume roughages. This may be supplied in the form of finely ground limestone or oyster shell. Approximately one-half ounce daily per lamb of either of these materials will supply adequate calcium.

Silage as the only roughage. It has long been believed that silage was not suitable to use as the only roughage for any class of sheep, mainly because of its low content of dry matter and its acidity. These are not so important, however, in bringing about unsatisfactory results, as is the failure to properly supplement the silage. Recent work has shown that silage may be fed as the only roughage to fattening lambs and good results secured, if the deficiencies of the silage with respect to protein and calcium are corrected through the use of suitable supplements. When this is done, a ration of corn, corn silage, soybean oil meal, or other supplement, and limestone may be expected to give results comparable with results obtained with most other rations fed since the intake of nutrients is similar. Such rations of good silage are palatable and do not result in any unsatisfactory conditions.

Indeed, one of the most recent results of the use of silage as the only roughage was to show the good qualities of a ration composed only of soybean oil meal, limestone, and corn silage. When about eighty per cent as much soybean oil meal was fed as corn and soybean oil meal combined, together with all the silage the lambs would eat, the protein concentrate and silage ration was superior to that containing corn in addition. Silage is one of the best roughages for lambs. The need to preserve as much as possible of the

nutrient content of our crops may see much greater use made of silage in the future.

Grain, supplement, hay, and silage. A widely advocated ration for fattening lambs is composed of grain, protein concentrate, legume hay, and corn silage. Such rations have been studied at many experiment stations and are certainly among the best. In such rations the various grains have relative values comparable with the values when used with hay. The protein supplement is usually fed in the proportion of one pound to seven pounds of corn, and sometimes slightly less with grains that have higher protein contents than corn. Legume hays are more valuable than nonlegume, although the use of a calcium supplement with the nonlegumes has been found to give them a better value. Corn silage is most frequently used, but many other silages are used too. Likewise, other materials are sometimes fed instead of silage. The use of beet pulp is common in many areas in the West. Whether such rations are more costly per pound of gain produced than rations of grains and legume hays depends much upon the cost of the supplement and silage. The rate of gain may be more rapid in some cases than with grain and hay, but the cost of gain does not always favor the more complex ration. The feeder must always consider conditions during the feeding period.

Choice of supplement. The choice of the various protein concentrates available should be made on the basis of the cost of a pound of protein, as there is no difference of consequence in the quality of the protein provided by them for lambs. Mixtures of two protein concentrates have not been found superior to one, but there are some reports that a combination of three has given better results than one. In most comparisons the amounts of supplements used have been the same, but the amounts of protein supplied by them have been different because of differences in protein content per pound.

Miscellaneous rations. Rations which do not come within the three preceding groups may be fully as efficient as rations that do belong in such classes. They are, however, put into a separate group because they contain feeds that are not generally available throughout all lamb-feeding areas. In fact, many of the miscellaneous rations contain some of the feeds found in the other three groups. This is especially true of some of the grains, particularly barley and corn, and of hay, particularly alfalfa. But used with

them are feeds such as sunflower silage, beet tops or beet top silage, wet or dried beet pulp, dried-molasses-beet pulp, beet molasses, cane molasses, cull potatoes, cull beans, cull raisins, distillers' dried grains, brewers' grains, packing-house by-products, fish meal, many other seeds or residues and milling by-products, and high nitrogen materials such as urea. For the most part these materials are used because, through their use, a saving can be made with respect to the amounts of grain and hay needed to fatten lambs. Most of these feeds, with the exception of the silages, beet tops and pulp, are fed in amounts of one-fourth to one-half pound daily per lamb, while the remainder of the ration is made up of the usual grains and hays. In the case of sunflower silage, beet tops, cull potatoes, and beet pulp, the amounts fed may range from one pound to four or five pounds daily. A very large percentage of the feeds fed in large amounts is made up of water.

While it is true that the usual chemical analysis of feeds may not reveal everything contained in the feed that is of nutritive value, yet, in lamb fattening, decisions as to the relative values of feeds may be based on the digestible protein and total digestible nutrient content with reasonable assurance that decisions so based will be correct. For example, the analysis of corn of number 3 grade shows that it contains 7.0 per cent of digestible protein and 79.0 per cent of total digestible nutrients. The analysis of cane molasses shows a digestible protein content of 0.9 per cent and a total digestible nutrient content of 56.6 per cent. Thus, unless molasses contains, in addition, some very highly valuable nutrient not revealed by this comparison, it is safe to assume that molasses is not worth as much per pound as corn for feeding lambs. This is shown by comparative feeding trials to be true. In most such trials molasses has shown a value of about 80 to 85 per cent that of corn. Since both feeds are low in protein, feeders who have plentiful supplies of farm grains need not buy molasses to use as a supplement to such grains. Molasses might be purchased, however, to replace corn because it could be bought cheaper per pound of nutrient content and would therefore cheapen the cost of feeding. Molasses is also bought at times as a means of improving the palatability of a ration. Most good rations do not require such treatment. Coarse fibrous roughages may be eaten if treated in this way, but their feed value is still low.

Many of the feeds included in this group of miscellaneous

ration materials are used as protein supplements. Some are much more palatable than others. Their values as protein supplements depend largely upon their digestible protein contents and how readily they are eaten. Urea contains no protein, but its nitrogen may become available to lambs through certain processes that occur in the paunch, and it is used as a source of protein. But it is so lacking in palatability to lambs that it cannot be given a high practical rating. Means whereby it may be more satisfactorily fed, than is true at present, may be found.

CHAPTER 35

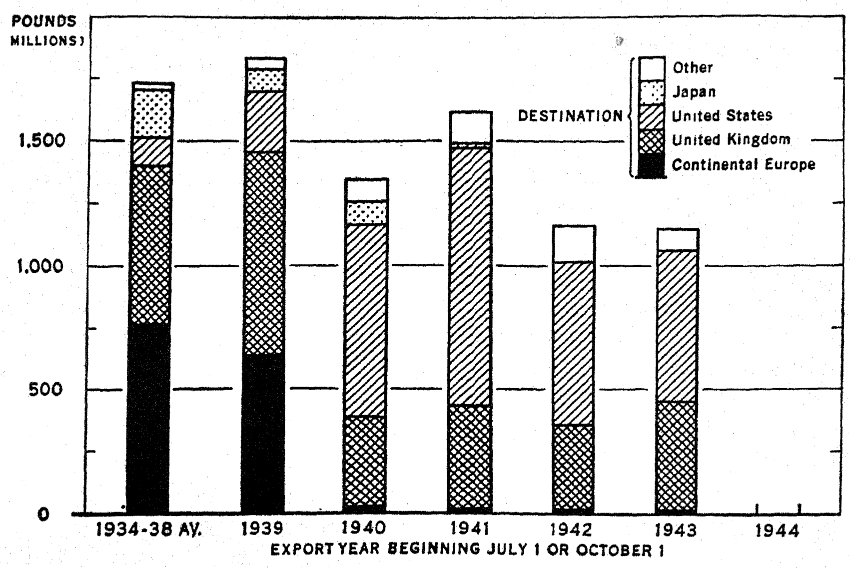
Wool

Wool is one of the world's great textile materials. For many centuries it has occupied a prominent place among all fibers, and its unique characteristics have enabled it to hold its prestige in competition with other animal fibers, those of plant origin, and those fabricated from various materials. It is most widely known as a material for apparel, blankets, upholstery, and carpets, but it has many uses in industry. Wool has been a matter of paramount importance in war and has been the concern of many legislative bodies throughout the world. It is produced mainly in temperate zones and enters into commerce as a feature of the national and international trade of many nations.

Uses. From 85 to 90 per cent of the apparel wool used in this country is used for fabrics for wear, and only 10 or 15 per cent is used for industrial fabrics. This is in sharp contrast to the cotton industry, where 45 per cent of the goods are used for industrial purposes and another 25 per cent for household purposes. Automobile cloth and blankets are the main industrial and household products made from apparel wool. Carpets and rugs are usually made from wool not classed as apparel wool.

Value. The wool-growing and manufacturing industries are important items in the economy of the United States. The Census for 1940 reported 584,935 farmers and rangemen as producers of wool valued at $165,000,000. Thus it is an industry that gives employment to many people in this phase. From the standpoint of manufacturing, the woolen and worsted industries ranked seventh in the number of workers employed and fourteenth in the value of finished products. Labor costs are thus shown as very important items in the value of the finished product, which is in great contrast to the cigarette industry which ranked sixth in value of product but sixty-third in number of people employed.

Frontier product. Most of the world's sheep have been kept



Courtesy U. S. Department of Agriculture

This chart shows the amount of wool exported from five Southern Hemisphere exporting countries, by destination, 1934–38 average, and 1939–43. These countries are Australia, New Zealand, South Africa, Argentina, and Uruguay, which normally supply about 85 per cent of the wool entering international trade. Before the war, Continental Europe and Japan were the normal outlets for more than half of the exportable surplus of wool of Southern Hemisphere countries. During the war years, exports dropped sharply and stocks accumulated, even though more than average amounts were shipped to the United States for use and storage.

in the less densely populated regions, and sheep raising has been a frontier or pioneer industry. This has been true because in such areas it has been possible to produce wool at a lower cost than elsewhere—the main competition for the use of such lands came from cattle—and because of the relative imperishable nature of wool, it could be transported long distances without much danger of deterioration. Wool, even though grown in the remote regions, moved freely in commerce because it required no refrigeration or expensive storage, nor was it necessary that it be used in a very short time. It only needed to be kept dry and given protection from some insects. Freight rates were low in comparison with its value, and it could be moved far from areas of production to areas

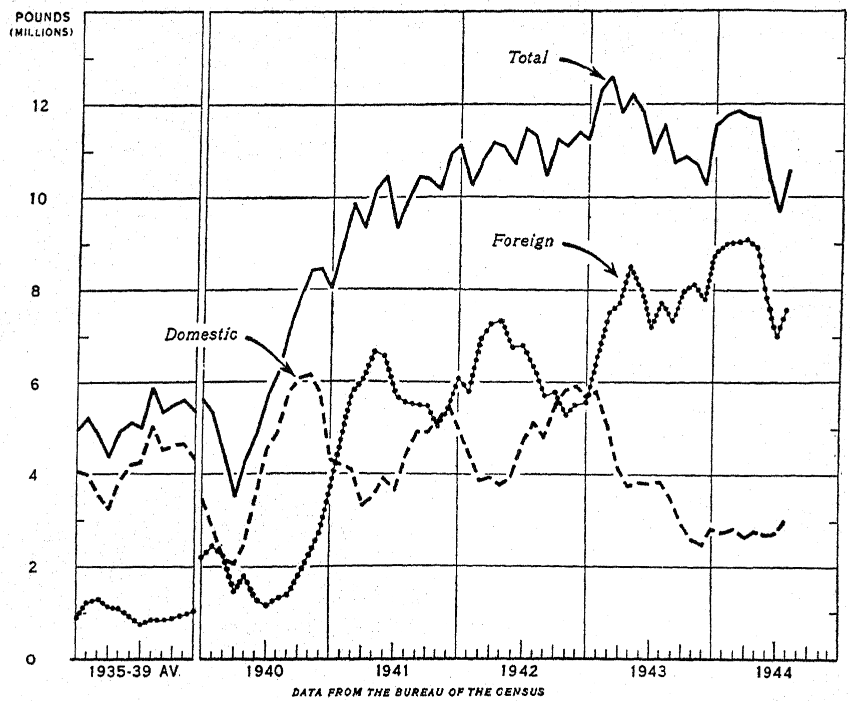
of consumption. Many of the factors that affected the wool grower's income were far away from his field of operation.

The Southern Hemisphere countries of Australia, New Zealand, South Africa, and South America are the main surplus-wool-producing regions. The United States is a large wool producer, but it is not an exporting country. On the contrary, to meet its need for wool, it is necessary that large quantities be imported. Some Asiatic countries produce large amounts of wool. In all of these countries most of the wool is grown in the sections where there is a sparse human population, and sheep raising can be carried on extensively. Thus, in the United States most of the wool comes from those states that have great areas of grazing land. Extensive wool growing is in the hands of relatively few men who control large numbers of sheep. It has been on this basis that sheep raising has been conducted for many years. Economic factors have a profound effect upon the industry, and a margin of profit is far from assured. Continuous adjustments are forced upon the industry.

Consuming centers. Wool consumption, on the other hand, has been and is greatest in centers of dense population. These centers of consumption are in the temperate zones of the Northern Hemisphere. The leading importing countries before the war were the United Kingdom, France, Germany, United States, Belgium, and Japan. During the war years, the world's wool supply was controlled by countries opposed to the Axis-dominated areas.

The dominant wool-handling country of the world is the United Kingdom. Its center of activity is London, where the world prices for wool are determined to a greater extent than at any other point. It is likely that a greater assortment of wool is available in London than in any other section. Much of the wool usually handled is manufactured in England for domestic use, although large amounts of cloth and other fabrics are exported. Much wool that is handled in London is also sold for re-export to Europe or to the United States. These countries also buy wool direct from surplus areas.

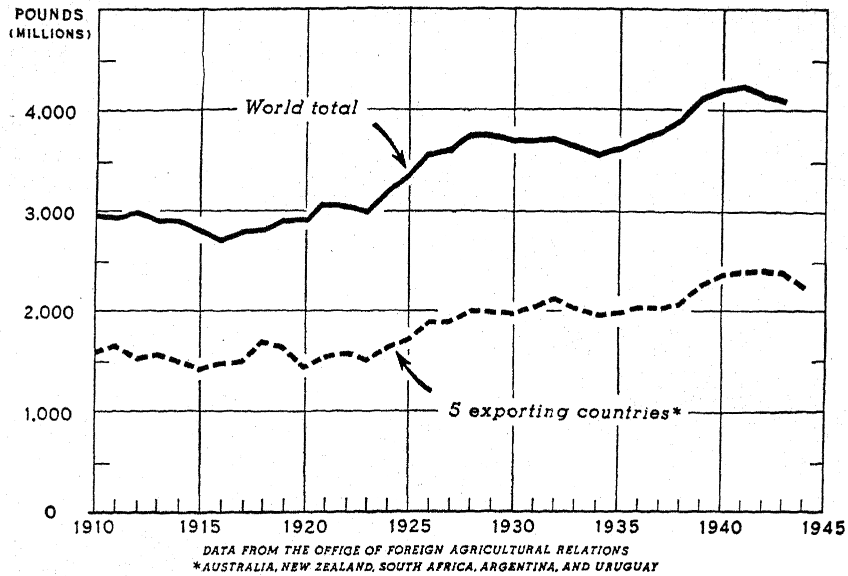
World industry. The cost of producing wool varies to a large degree in different countries. These variations are due mainly to differences in the capital investment required, the costs of labor, and the costs of supplies. Costs of wool growing in the United States have been considerably above the costs in most other countries. Likewise, the costs of manufacturing have been above those of



Courtesy U. S. Department of Agriculture

This graph shows mill consumption by place of origin, of apparel wool, scoured basis, United States, 1935–39 average, and 1940–44. The importance of wool during wartime is shown by the large increase in consumption after 1940 compared with the years 1935–39. Although military requirements were materially reduced after 1944, total government and civilian demand was large enough to support a record annual rate of wool consumption. Because foreign wools were available at much lower prices than domestic wool, little domestic wool was used in civilian fabrics, and its consumption declined sharply with the decline in production of army fabrics.

other centers. These differences, together with the desire to provide some protection to an industry that has been vital in wartime and of far-reaching importance in peace and the need for revenue have been the main basis for the tariff or import duties on wool or goods made of wool. There are differences too in the fundamental economic theories of members of the government, that have entered into many debates on tariff policies. These and other differences still exist, and the possibility of changes in policies is a matter that



Courtesy U. S. Department of Agriculture

This chart shows world production and production in five Southern Hemisphere exporting countries of wool, grease basis, 1910–44. Probably the world record production of wool occurred in 1941. Droughts and other handicaps brought on by the war caused some decline thereafter, but stocks of wool owned by the United States and her Allies at the close of the war were very large. Extensive plans for the orderly disposal of these stocks were made in order not to bring about drastic price declines. Production in 1945 was estimated at 3,760,000,000 pounds.

is of much concern to the wool producer and the manufacturer and the workers in the various branches of the industry. Past actions may not have any effect upon the industry at present, but the informed student and sheep raiser should have some familiarity with the tariff acts passed by the government. Since wool growing is a world industry, it is affected by an extremely wide range of conditions. Up-to-date statistics must occupy the attention of the grower if he is to be acquainted with the world-wide situation at any time.

Tariffs. There are essentially two kinds of tariffs. These are known as ad valorem and specific. Ad valorem tariffs are levied on the value of the material imported and stated as a percentage of that value. From the standpoint of either protection or revenue,

the ad valorem tariff gives greatest return when prices are highest and least when they are lowest and probably most needed. These have been the main objections to such tariffs on the part of the wool growers. Specific duties are levied on the amount of the material, such as a certain number of cents per pound for each pound of wool imported. More wool fiber could be brought in, when it was relatively free of dirt, grease, and other materials, for the same amount of tariff than when there was much foreign material mixed with the wool. Wool growers have preferred to have the duty based on the actual amount of wool fiber (clean wool) rather than on a grease- or raw-wool basis. This has lead to efforts to determine with reasonable accuracy the clean content of raw-wool shipments into this country. Estimates of the shrinkage (amount of foreign material and grease) have not been very satisfactory on many occasions. Specific duties on wool may vary with the class of wool. On some occasions combinations of ad valorem and specific duties have been used. There has been much debate over the relative amounts of duties that should be levied on wool and on fabrics made from wool. During the last century (1861) the principle of the compensating duty was introduced to take care of this need.

Most of the tariffs enacted by the congress have represented compromises reached after extensive hearings. The record of these hearings contain much factual information regarding the sheep-raising and wool-manufacturing industries of many countries. Only a brief sketch of wool tariff legislation is given here.

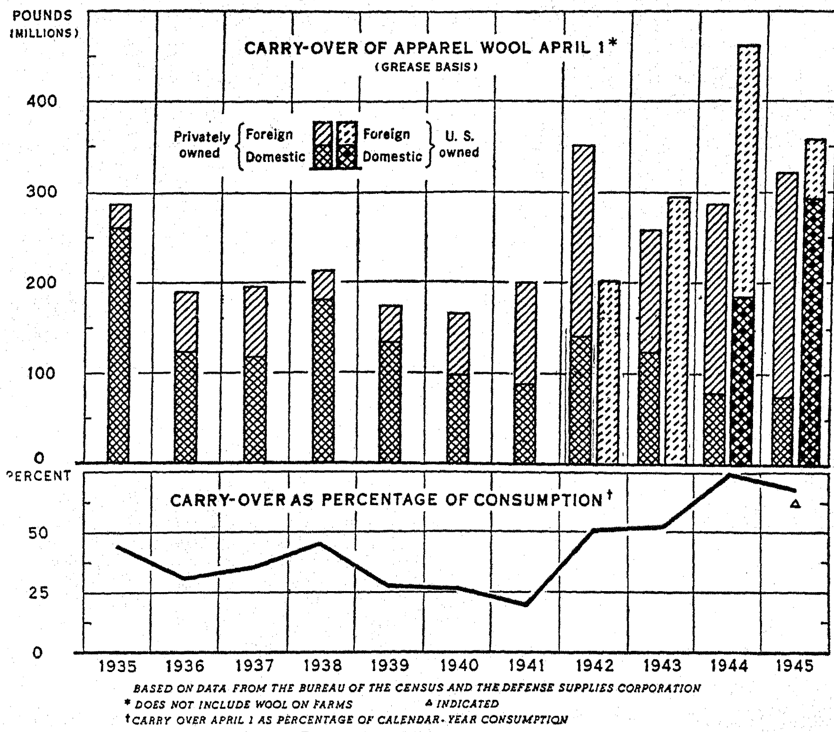
The Tariff Act of 1789 was the first legislative measure of the kind passed in the United States. Wool was not included in tariff legislation until 1816 when an ad valorem duty of 15 per cent was placed on wool and 25 per cent on woolen goods. Prior to that time sheep raising and wool manufacturing had been stimulated by the Embargo Act of 1807 and the Non-Intercourse Act of 1809, but particularly by the War of 1812. After that war large exports by the British depressed the industry and led to the legislation of 1816. Rates were changed in 1824, and in 1828 a combination of ad valorem and specific rates was tried. This was followed by changes in rates and manner of levying them in 1832, 1833, 1841, 1842, 1846, 1857, and 1861 when the compensatory principle was applied to the tariffs. This was based on the assumption that four pounds of raw wool would make one pound of cloth. This was true for certain types of wool that had certain losses of weight in

manufacturing, but it led to the importation of the lighter-shrinking wools and thus had the effect of lowering the protection intended for the wool growers. Rates were changed again in 1864.

In the Act of 1867 wool was more carefully defined and classified than earlier. The so-called "blood classification" was introduced and wools were designated as clothing, combing, and carpet. Legislation to modify rates and make other minor changes was enacted in 1872, 1875, 1883, and 1890. From August, 1894, to July, 1897, wool was on the "free list"; that is, there was no duty on its importation. Many stories of tragedy and humor are told of the time. Prices declined and sheep numbers were reduced. Tariffs were restored in 1897, and some adjustments were made in 1909. From October, 1913, until May, 1921, wool was again on the "free list." These two periods are the only times when there have been no duties on wool imports. Because of the severe depression of sheep and wool prices in 1921, an emergency act was passed which placed specific duties on wool; the rates varied with the condition of the wool, whether raw, washed, or scoured. To correct some of the discrepancies of the act, another was passed the following year, the main feature of which was the levy of a duty of 31 cents per pound clean content on raw wool of certain descriptions. If wool did not show the influence of the Merino or British breeds of sheep, it was admitted free if used for floor coverings but became dutiable if used for clothing.

In 1930, official standards of fineness for wool grades for tariff purposes were made a part of the act. Coarse wools used for carpets may be imported free, as little wool of that type is produced in this country. If not used for carpets, the duty is 24 cents per pound clean basis. Wools that are finer than 44's, that is, medium- and fine-grade wools, carry a duty of 34 cents a pound clean content. Later legislation pertaining to trade agreements has authorized the president of the United States to change duties as much as 50 per cent, but this power has not been used.

Postwar aspects. During the war periods various controls are exercised with respect to most strategic commodities, and huge stockpiles are developed. Postwar periods have always brought severe conditions with which wool growers have had to cope. World wool supplies are large at this time (1946), demands are also large, and there are great shortages of civilian woolen goods in many countries. A number of proposals for the postwar period



Courtesy Bureau of Agricultural Economics, U.S.D.A.

This chart shows the carry-over of apparel wool April 1, actual and as percentage of annual mill consumption, United States, 1935–45. At the close of the war there were large stocks of wool in the United States. The need for goods is widespread and the carry-over will be used gradually. In 1946 prospects are for some reduction in most of the important producing countries.

have been made with respect to wool imports. Among these suggestions was a quota system to regulate imports from various countries. This together with the tariff is believed by advocates as necessary to enable sheep raisers to continue. Much reduction in sheep numbers during the war years occurred because of the lack of labor, high costs, and emphasis by government agencies on other products not available in such quantities as wool.

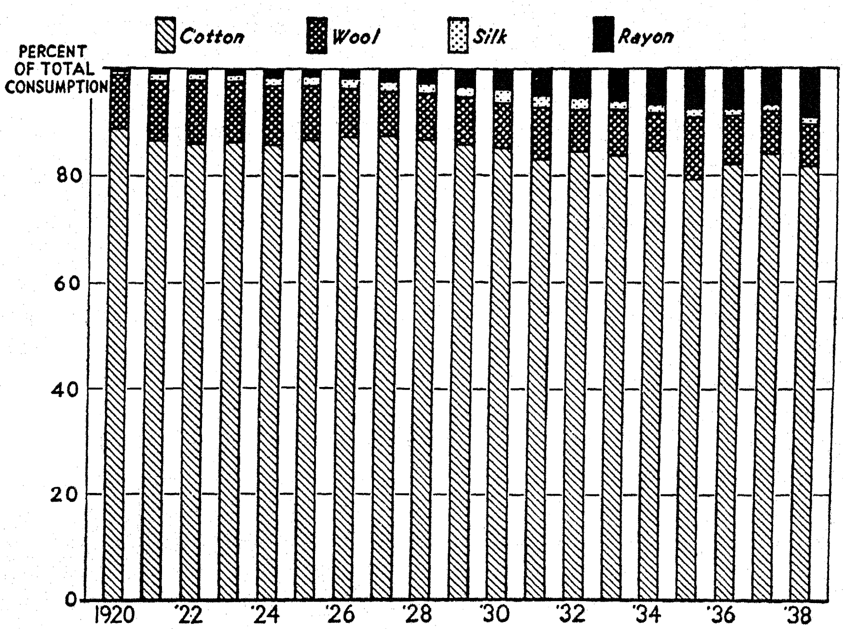
The price of wool is higher in the United States than in other countries. Whether this is entirely due to the tariff and whether the tariff is beneficial to the wool growers, manufacturers, and to the

public are subjects that are earnestly debated. It is a fact that wool prices are kept at a higher level by the tariff than they otherwise would be, but there are, nevertheless, marked fluctuations in prices. Much of the domestic economy, like the wool industry, has developed under a tariff system, and a sudden relinquishment of tariffs would cause drastic changes.

Wool growers in this country have other competition than that which comes from wool imports from foreign lands. There are not only imports of wool and woolen fabrics, but there are large amounts of rags, wastes, and noils imported, from which fabrics are made by reworking them. In addition, there are rags and wastes gathered in this country which are re-used for various purposes. Some of these materials which are generally referred to by the term "shoddy" are used in the manufacture of woolen goods, but little or none is used for the manufacture of worsted-type fabrics. Considerable quantities are used too for rug pads, roofing felt, and other purposes for which new wool would be too expensive. There are a number of more specific terms used in referring to these used materials; some of them are defined in the glossary.

Fabric labeling. The analysis of fabrics is beyond the abilities and knowledge of most consumers. In order to protect them in their purchases, the law now requires that fabrics be labeled with the kind of fibers which they contain. Wool which has not previously been used is designated as new or virgin wool; that which has been previously used may be designated as re-used or reworked wool. If other fibers are used with the wool, the fabric labeling act requires that they be designated also. While there has been some opposition to this law, it has been beneficial to both growers and consumers. The act does not prohibit the use of any fibers which the manufacturers may want to use, but it does require that the fiber content of the material be given. Styles and the need for economy have great effect upon the types of fabrics made as a result of the demands of consumers. The very highest grades of re-used wool may be as good or even better than very poorly grown low-grade new wool. For the most part, virgin wool is superior, and fabrics made from the best grades of such wool are the most expensive and serviceable.

Foreign wool and foreign-made goods are sometimes spoken of as vastly superior to those of domestic origin. Environment and



Courtesy Textile Economics Bureau, Inc.

This chart shows the domestic textile fiber consumption, 1920–1938. Although no synthetic fiber has yet reached the importance of a substitute for wool, growers should be ever watchful of the increased consumption of synthetic fibers.

breeding have effects upon wool, but it has never been proved that all foreign wool is better than much of the domestic wool. The best foreign wool may be better than the best domestic wool, but at least a part of the expressed superiority is fancied. There are differences in the way the wool is prepared for market and in the shrinkages, but the differences in the actual fibers are not as evident as is often implied. Some of the wool, especially that from Australia and New Zealand, when of a certain fineness, may be superior in length, softness, and uniformity of fineness, but little if any is superior to domestic wool in color and strength. It is unlikely that wools from other countries are better than similar wool grown by good producers in this country. Workmanship in manufacturing is a matter apart from the wool fiber's inherent characteristics.

CHAPTER 36

★ *The Meaning of Wool Terms* ★

The study of wool is a specialized field. Many terms are used to describe various features of the wool fiber and kinds of wool, as well as to designate different steps in wool handling, marketing, and manufacturing. The products and by-products of wool are known by certain names. If one is to have an intelligent basis for developing a thorough comprehension of the subject and have a foundation for further study, many of these terms must be well understood. Because some of these terms are used in the material that follows, a listing and definitions are given here. The sheep raiser is not apt to use all of these terms, but he will encounter them in various reports and articles and should have a reasonably accurate knowledge of them. Many of them are in everyday use by the best informed men engaged in the sheep industry.

American grades. In general, seven grades of wool indicated by the terms fine, half, three-eighths, quarter, low quarter, common, and braid.

Apparel wools. Any wool that is manufactured into cloth for use as clothing.

Astrakan. A grade of Karakul lambskins that is less lustrous, with longer hair and more open curl than on some other grades.

B. A. 1's, 2's, et cetera. These are designations of grades of wool from Buenos Aires, Argentina. The lower the number, the finer the wool. Thus, 1's is approximately equal in fineness to three-eighths blood (56's), and low half-blood is called Primas.

Bale. Wool production for some countries is given in bales rather than as pounds or tons. Australian and New Zealand wools weigh about 330 pounds per bale; South American bales weigh approximately 1,000 pounds.

Black wool or blacks. Fleeces that are gray or black or any shade other than white. Blacks sell at a discount with a comparable grade of white wool.

Blood. The term blood is used along with half, three-eighths, quarter, and low quarter to indicate degree of fineness of wool. These terms now have no relation to the breeding of the sheep from which the wool was obtained.

Botany. A term applied to some goods made from fine wool and also applied to fine wool from Australia.

Braid. The coarsest of the United States grades of wool. Most braid wool is lustrous and is from the long-wool breeds.

Breech or britch. Wool, usually the coarsest in the fleece, from the lower parts of the hindquarters.

Bright wool. Wool that is light-colored and of light shrinkage, largely from the northern states east of the Mississippi River. Semi-bright wool is generally from states along the Missouri River. Semi-bright wool is as white as bright wool after scouring.

Broadtail. A type of lambskin with a very beautiful, wavy pattern usually obtained from prematurely born Karakul lambs or those killed soon after birth.

Bucks or buck wool. The wool from rams. It is distinguished from ewe or wether wool by its odor and usually heavier shrinkage caused by a greater amount of grease. It often sells at about one-half or two-thirds the price of other wool, partly because of its shrinkage and also because it may have coarse hairs mixed with the wool fibers.

Burry wool. Wool that contains burrs from any of the plants. Such wool requires special processing in manufacturing, is higher in shrinkage, and hence sells at a discount compared with "clear" (free-of-burrs) wool. Light burry and hard burry are used in referring to the amount of burrs. Fine burry, medium burry refer to the grade of the wool.

Cape wool or Capes. Wool from South Africa.

Caracul. A type of Karakul lambskin.

Carbonizing. The use of chemicals, usually acids, to destroy and remove the burrs without any serious damage to the wool. Wool so treated is carbonized wool.

Card. A many-toothed tool or machine used to open the wool fibers by opening the locks or tufts of wool. Hand cards are now used chiefly in the fitting of show sheep.

Carding. One of the first steps in the preparation of scoured wool for further processing. In the process the wool fibers are separated from other fibers in the locks or bunches of wool.

Carpet wool. Low-grade coarse wool, generally from unimproved sheep, used in the manufacture of carpets and rugs. It may also be used for coarse wearing apparel. Some rugs are made from finer grades of wool than that usually thought of as carpet wool. There is little carpet wool produced in the United States; most comes from Asiatic areas.

Character. The evenness and distinctness of crimp in wool fibers.

Class or classification of wool. A means of designating wools. The methods of classifying wools differ to some extent. In this country wool classes are generally thought of as combing or wools suitable for top making, clothing wool—that which is too short to comb, and carpet wool. Another way of classifying wool is as apparel wool and carpet wool.

Classing. Australian term for grading. Usually done at wool-growing stations.

Clean basis. Quotations of prices that are based on the estimated weight of fiber a particular lot of grease wool may contain. In this country wool that is sold on the clean basis has its yield estimated as a percentage of the total weight. The price paid for the grease weight of the wool is then calculated from this estimate and the value of the clean wool per pound. Other expressions of the same thing are clean cost and clean content.

Clip. The process of shearing, clipping. The weight or type of the wool from a certain flock. Also, the yearly total production.

Clothing wool. Wool that is too short to be combed. Hence, the basis of designation is one of length. These short-fibered wools are used chiefly in the manufacture of woolens and felts. Sometimes called woolen wools.

Combing. An operation in the manufacture of worsteds that separates the short fibers, known as noils, from the longer fibers which are combed into a continuous strand in which the fibers are parallel. The finished product is known as top.

Combing wool. Wool that is strong and is long enough to be combed. In the United States Standards, fine combing wool is two inches or more in length. The length increases at least one-fourth inch for each grade as the wool gets coarser.

Comeback. A sheep or wool from a sheep that has a crossbred dam and a fine-wool sire (Merino). Wool of this kind has good length and is about half blood or 58's and 60's quality.

Common. One of the grades of wool in the United States. It is next to the coarsest grade and was so named because it came from the common sheep of the country, in contrast with the early Merinos.

Condition. A term used in referring to the amount of grease and dirt in wool. Wool that is heavy in condition shrinks or loses a large percentage of its weight in scouring. In scoured wool condition refers to the percentage of moisture. Wool "works" best with certain percentages of moisture, and manufacturers "condition" wool to this degree.

Cotted fleeces (Cotts). Those fleeces in which the fibers are matted or felted. The condition is most common in coarse-wool sheep and may be due to ill health or the lack of sufficient yolk. The fibers must be torn apart with machinery, and many fibers are broken.

Crimp. The natural waviness in the fibers.

Crossbred wool. In the United States this term refers to wool from sheep that are from a fine-wool and long-wool cross. Such wool is about as coarse as three-eighths blood wool or at least as coarse as half blood.

Crutchings. Wool shorn from the breech and inside of the hindlegs before the regular shearing as a part of the flock management. Most widely practiced in Australia as a protection against blowflies.

Dead wool. Also called fallen wool. Wool removed from the dead sheep on farms and ranches.

Defective wool. Wool that is burry or has been damaged by water, fire, insects, or disease, hence has a reduced value after scouring.

Degras. Crude wool grease is so known in commerce.

Delaine. Practically synonymous with fine combing wool. Delaine is applied to such wools from Ohio and other middle western states but does not necessarily come from Delaine Merinos.

Depilatory. A solution or paste applied to the flesh side of pelts in the wool-pulling process to loosen the fibers from the skin.

Dingy. Wool that has a dark or grayish color and generally heavy in shrinkage.

Domestic. Wool produced in this country in contrast with foreign-grown wool. Also used in reference to wool from the middle

and eastern states in contrast with that from the western areas.

Down wool. Wool that is clipped from the breeds that originated in the downs of England. It is chiefly of medium grades.

Fall wool or fall-shorn wool. Also called 6-months wool. That which has attained a growth of from four to six months and is sheared in the fall. It comes mainly from the southwestern states and is usually less desirable than spring-shorn wool. Twelve months' wools constitute about 95 per cent of the total annual clip.

Fellmonger. A dealer in pelts and pulled wool.

Felting. The interlocking of wool fibers, which may be caused by heat, moisture, and friction.

Filling (weft). Threads that run crosswise in a fabric and thus fill in between the warp.

Fleece wools. A trade term for wool from the eastern and central states.

French combing. Wool that is shorter than strictly combing but yet long enough to comb on French combs. It is longer than clothing wool.

Fribs. Short, dirty bits of wool or those tufts that result from second cuts during shearing.

Frowsy. Wool that is dry and lifeless without distinct crimp due to weathering or to poor quality or both.

Fulling. A step in woolen manufacture whereby the cloth is shrunk, the fabric is "faced," and the weave pattern is covered.

Gare. A term more generally used abroad than in this country, meaning straight, coarse, usually lustrous fibers, sometimes incorrectly called kemp, that are mixed with fine fibers. Often found on the folds of fine-wool sheep.

Grade. A means of designating wool according to the fineness of fiber.

Grading. The process of determining the grade of wool. It is done by examining the unopened fleeces and sorting them into lots according to fineness. As this is done the fleeces are also classified on the basis of length of the fibers.

Grease wool. Wool in the condition in which it is shorn, before washing or scouring.

Gummy. Grease wool that has an excessive amount of yolk or scoured wool that still has some yolk in it.

Hank. A measure of length for yarn; a hank of worsted yarn contains 560 yards.

Hoggett (Hogg) wool. A term used outside the United States to designate the first fleece from a sheep.

Kemp. A chalky white, brittle, weak fiber which, found mixed with normal fibers of a fleece, constitutes a very serious defect. Kemp will not take dyes and lacks strength.

Lambs' wool. Short wool that is supposed to be from lambs not over 7 or 8 months of age. Some wool is graded as lambs' wool and is from lambs of 12 to 14 months of age. It is soft and has less felting properties than sheep wool.

Lanolin. Refined yolk or wool grease. It has many uses among which are various cosmetics.

Locks. Pieces of wool loosened from the main fleece and packed separately in the Australian method of packing wool.

Lofty. Wool or a woolen fabric that has "life" or springiness when compressed and is bulky in comparison with its weight. Lofty wool is light in condition and has very even, distinct crimp.

Luster wool. Wool that shines because it reflects more than the usual amount of light. It is chiefly from the long-wool breeds.

Modock. A term formerly used in referring to wool from range lambs that had been fed in the farm states. Now called fed-lamb wool.

Mohair. The fiber from the Angora goat.

Mouton. A modern fur made by the chemical treatment of the wool on sheep skins.

Mungo. Recovered fibers from clippings of tailor shops and from felted rags.

Murrain. Same as dead wool. Detected by graders by its odor.

Mushy. Wool that is dry, weathered, and wasty. Same as frowsy.

Noils. Short fibers removed in the process of combing. They are useable in the woolen industry.

Off-sorts. Fleeces or parts of fleeces that are rejected as unsuitable for the regular lots of graded wools because of being badly stained, having undesirable color, et cetera. Rejects.

Original bag wools. Those which are usually at least 85 per cent of one grade and can be sold to manufacturers in the bags in which packed at shearing time.

Pelt. The skin and wool together.

Persian lamb. A very desirable, tightly curled, highly lustrous Karakul skin.

Picklock. Formerly a grade of very fine wool. Obsolete.

Pieces. Skirtings or other pieces of wool removed from the main part of the fleece and packed separately in the Australian system.

Pool. Assembling several clips for sale at one time.

Pulled wool. Wool that is removed from the skins of slaughtered sheep by means of a depilatory, "sweating," or some other process.

Purity. A term used generally in reference to the unshorn fleeces that are free of dark fibers, kemp, or gare.

Quality. This term is used to designate the fineness of wool fibers. The quality is given in the American or Bradford Systems by applying to wool of a certain degree of fineness the corresponding accepted term; such as, half blood, or 60's. Quality is sometimes used in referring to strength and color.

Raw wool. Wool in the grease.

Regain. The percentage increase in weight due to the moisture, compared with the moisture-free weight. It also means the amount of moisture that wool or a fabric will naturally absorb from the air with a certain relative humidity.

Rejects. The same as off-sorts.

Reworked wool. Most wools that have been previously used in manufacture have been included under the term shoddy, but this term does not have the same derogatory implications as shoddy.

Robust. An Australian term used to describe Merino wool that is relatively coarse compared with other Merino wools. Also called strong. Merino wool may be fine, medium, or strong.

Run-out fleece. Wool that is very lacking in uniformity, being hairy or kempy in the breech or elsewhere.

Scouring (scoured, scoured basis). The process by which the grease and dirt are removed from wool, usually through the use of a warm solution of soap and sodium carbonate, or by means of a solvent such as naphtha. After the process, wool is spoken of as scoured, and trading either before or after may be on a clean or scoured basis.

Semi-bright. Wool that lacks brightness due to the environment under which produced. It is as white as other wool after scouring.

Serrations. The outer scales of the wool fibers show irregular saw-tooth edges called serrations. Visible under a microscope.

Shafty. Wool that is well grown, strong, and of good length for its grade. Used mainly abroad.

Shearlings. Pelts of slaughtered sheep that have been recently shorn and have less than about an inch of wool. Also, wool pulled from such pelts. Also, an English term for a yearling sheep.

Shoddy. Wool fibers recovered from old or new woven rags.

Shrinkage. The percentage loss in weight due to scouring. Very important in determining the grease value of wool.

Skirting (skirted). Removing the inferior and heavy-shrinking parts of a fleece before it is packed for sale. Commonly practiced in Australia and many other countries.

Slipes (slipe wool). British term for pulled wool.

Sound (soundness). Wool that has good strength.

Sorting. Dividing the fleece into its various qualities. Not grading.

Spinning counts or counts. A numerical system of wool grading on the basis of the number of hanks of yarn that can be spun from it. The count indicates the number of hanks each of 560 yards that it will take to weigh a pound.

Spot wools. Those ready for immediate delivery.

Spring wool. Wool shorn in the spring in contrast with fall wool where sheep are shorn twice a year. It is preferred to fall wool as it is longer stapled.

Stained wool. Wool that has been stained by urine or otherwise so that it cannot be scoured to a pure white color. Subject to price discount.

Staple. Now commonly used in reference to length of wool fibers. It is measured without stretching to remove the crimp which would give the fiber length. Fine staple wool from the western areas means the same as fine combing from other sections. Staple also means a lock or bunch of wool fibers as they exist in the fleece.

Stubble (stubble shearing). Shearing a short distance from the skin. Usual with show sheep.

Suint. The water-soluble perspiration naturally found in a fleece. It is mixed with the yolk.

Sweating process. Piling sheep skins in a warm, moist room to loosen the wool for pulling.

Sweat shed or pen. Used to hold sheep so they will sweat before they are shorn. This softens the yolk and makes shearing easier.

Tags. The heavy manure-covered locks.

Tare. The weight of the wool sacks deducted before payment is made for the wool.

Tender. Wool that is weak and breaks easily. Tender wool is usually due to poor nutrition or sickness.

Territory. Wool from the areas west of the Missouri River in contrast to that from the native or fleece-wool states.

Tippy wool. That in which the tip or weather end of the fibers are encrusted, making the wool wasty in processing.

Top. A strand of partially manufactured wool. It has been scoured and combed, and the fibers lie parallel in the strand. Wool in this form is ready to be drawn and spun and is a standard commercial article and is dealt in on the futures market.

Tub washed. Wool that was washed by the producer before it was sold. The practice is not followed at present.

Unmerchantable. Wool that was so poorly washed as to be undesirable. Obsolete since the discontinuance of farm washing of wool.

Unwashed. Wool in the grease.

Virgin wool. That which has been used in fabrics for the first time in contrast with wool that may be called all wool or pure wool but which has been recovered from previously made materials.

Warp. The threads of a fabric that run lengthwise. They must be strong to withstand the strains of weaving.

Washed wool. Wool from sheep washed before they were shorn. Another out-of-date practice in this country but followed to some extent in England.

Wasty. Wool that will lose much in manufacturing because it is short, weak, and tangled.

Weft. The opposite of warp. See filling.

Wool fat (grease). See degras and lanolin.

Woolens. Fabrics made from uncombed wool.

Wool-sorters disease. Anthrax, formerly a common disease of sheep that was sometimes contracted by wool handlers.

Worsteds. Fabrics made from combed wool.

Yield. The opposite of shrinkage. The percentage of clean wool fibers after scouring.

Yolk. The secretion of sebaceous or oil glands in the skin. A certain amount is needed to keep the wool in good condition.

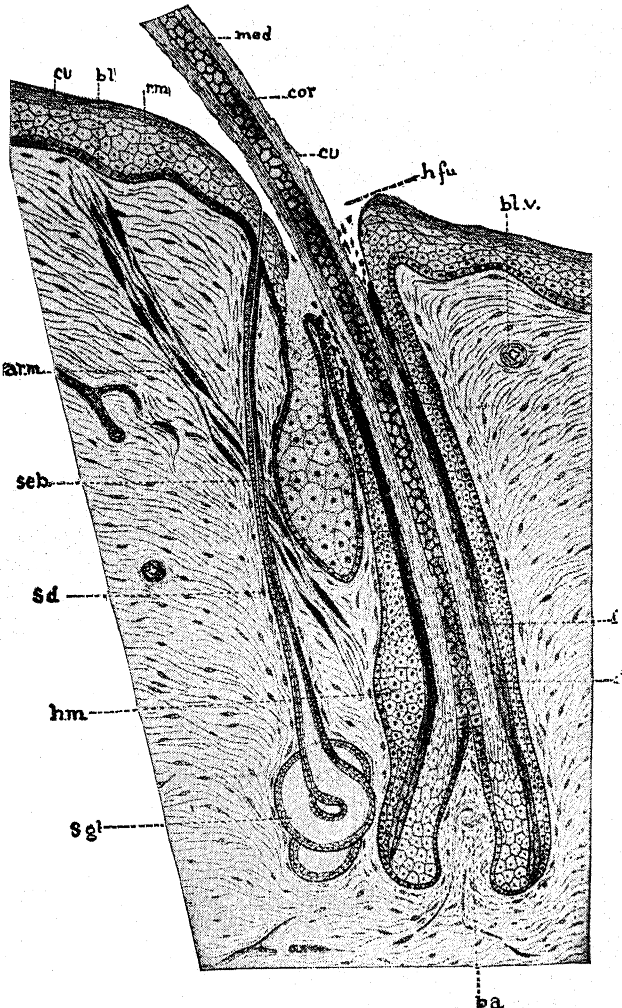
CHAPTER 37

★ *The Wool Fiber* ★

Growth. Wool fibers grow from follicles in the skin. Growth or elongation occurs at the base of the fiber and not at the tip. In the sheep found in this country, the processes of growth are continuous, and it is likely that if environmental conditions were exactly uniform there would be very little difference in rate of growth from season to season. Shearing does not particularly stimulate growth of wool fibers. The wool growth on some wethers left unshorn for a period of five years was remarkably uniform.

The skin consists of two layers. The epidermis or outer layer serves mainly as a protection to the dermis or corium, which is composed of connective tissue and is well supplied with blood vessels and nerves. This layer also contains glands which secrete the yolk and others which produce perspiration. The latter open onto the surface of the skin, but the oil glands open into the hair follicles which are minute depressions or invaginations. It is within these follicles that the wool fibers are elaborated, and as cells are added to the fibers they are slowly extended outward. Anything which interferes with this process causes a weakening of the fiber or, in very severe cases, a complete cessation of growth with a consequent "break" and loss of the fleece.

Cells of wool fiber. Like the skin the wool fiber contains two layers of cells. The outer layer is scale-like and is known as the epidermal layer. These epidermal cells overlap with a serrated loose end pointed toward the tip of the fiber. Fine wool has many more serrations per inch than coarse wool; these differences may be as great as 500 or 600 in the latter to ten or more times as many for the finest fibers. Underneath the epidermal layer is the main part of the fiber known as the cortex. The cortical cells are spindle-shaped and give to the fiber its strength and elasticity. According to some writers the irregular arrangement of the cortical cells is the cause of the crimp. However, others ascribe crimp formation to



From South African Journal of Science, Vol. XXI

A vertical section of growing medullated fiber is enlarged 90 times to show wool fiber within the follicles of the skin and fat and sweat glands. While the drawing shows the medulla (med) as well as the cortex (cor) and cuticle (cu) of the fiber, the general development without the medullary layer would be the same. H.fu., hair funnel; bl.v., blood vessel; b.l., basal layer; r.m., rete mucosum; ar.m., arrector muscles; seb., sebaceous gland; s.d., duct of sweat gland; s.gl., sweat gland; h.m., hair matrix; i., inner root sheath; pa., papilla of fiber.

different causes. When wool fibers are treated with weak caustic solutions, the two layers of cells may be separated, and this separation may be seen when the fibers are viewed under a microscope.

Some wool fibers have a third or middle layer of cells known as the medulla. These are generally described as globular in shape, and they may be found throughout the length of the fibers, or they may be found only in some parts of the fibers. Medullary cells may contain air or a granular pigment material. Such fibers are not the same as kemp, as the latter are chiefly medullary cells with only a very thin layer of corticle and cuticle materials. Wool fibers containing medulla are not desirable, as they lack the working properties of non-medullated fibers. Such fibers are generally coarse and uneven in diameter and are harsh in "handle," as they are low in elasticity and pliability, although they have considerable tensile strength. This condition is found most frequently in coarse or poorly bred wools. Some workers have associated the condition with nutrition, but it seems far more likely that it is chiefly a matter of genetics. Some too have differentiated between hair and wool on the basis of the medulla, but this seems impossible to verify.

Wool and hair. The main differences between hair and wool are: wool fibers are usually much smaller in diameter; the epidermal cells of hair are fastened to the cortex throughout their length; hair is always medulated; hair never is crimped like fine wool, although some is wavy like the coarser wools; both hair and wool may have pigment within the cortex, but most wool is free of pigment. Wool fibers grow much denser on the skin than hair grows. In very dense-fleeced, fine-wool sheep there may be more than 50,000 fibers per square inch of skin area. In the coarser, loose-fleeced sheep the number may not exceed 5,000 per square inch.

Variations on body. Variations in wool covering in different sheep are extremely large. Some sheep have wool fibers that are hard to distinguish from hair. In some, only the main portion of the body is covered, while in others the wool extends from just above the nostrils to the feet. Wool on any one sheep is never uniform in length or fineness. The finest and densest wool fibers are found on the shoulders, about midway between the top of the shoulders and floor of the chest; the coarsest wool is about the breech and dock; the shortest wool is usually on the belly. Sheep with a dense growth of relatively long wool on the main parts of the body yield the heaviest fleeces.

Adhering materials. In the raw state, wool contains various adhering materials which may be considered as impurities. Some of these are not necessarily disadvantages as they may be essential to the proper preservation of the fiber while it is being developed to a length suitable for use. The amounts of these materials vary widely; the chief influences are those inherent in the sheep and those associated with environment, such as climatic and nutritional factors. The adhering materials consist of yolk, suint, vegetable matter, dirt, and moisture. In some cases these materials make up a greater percentage of the entire weight than does the wool fiber. The percentages for different kinds of wool may show such wide variations as follows:

	Variations in per cent of grease weight
Wool fiber	15 to 75
Yolk	7 to 40
Suint	5 to 15
Foreign materials	5 to 40
Moisture	3 to 20

These figures are approximations taken from various sources and are intended merely to show what matters may influence the weight of raw wool obtained from a sheep. Furthermore, these amounts differ widely, depending upon what part of the fleece is selected for examination.

Yolk. Yolk or wool grease seems to be of direct importance in the preservation of the fiber from detrimental action by the weather. Wool that is lacking in yolk may show considerable damage, especially near the tip. On the other hand there is no apparent advantage in an amount of yolk beyond the minimum amount needed to afford such protection. The amount of yolk secreted by fine-wooled, dense-fleeced sheep is much greater than the amount found in the wool of loose, coarse-fleeced animals. Yolk is a mixture of a number of materials of which the principal one is cholesterol. This is not a true fat, and it does not form soap when combined with alkali. It is soluble in ether, alcohol, benzene, et cetera. Much of it can be removed with water, with which it forms an emulsion. When purified, it has a number of uses in industry, such as in oint-

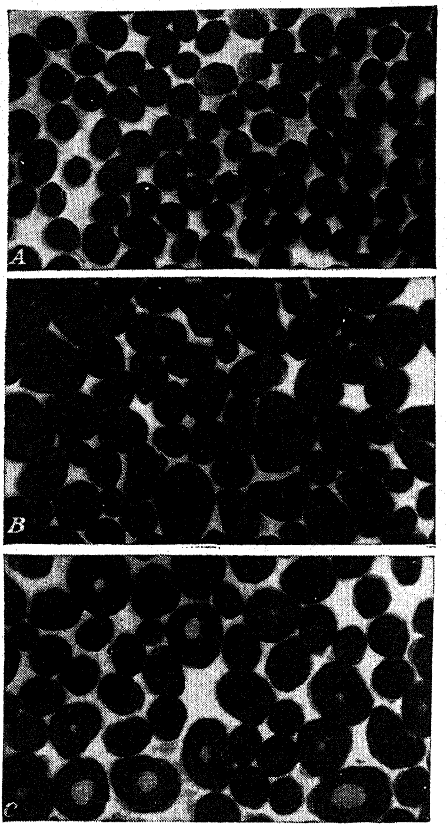
ments, cosmetics, leather dressing, rope making, and rust preventive.

Suint. Suint cannot be distinguished from yolk, as the two are mixed together in the grease found in raw wool. Suint is very different from yolk, however, as it is readily dissolved in water. Because of this and because it has emulsifying and cleansing properties, some consideration is given to its presence in wool scouring, and purified suint may be added to the scouring bowls. It consists chiefly of potassium salts of various fatty acids and lesser amounts of sulphates, phosphates, and nitrogenous materials. There has been no relationship reported between the suint and wool production. It seems to be the source of the odor associated with sheep.

Wool studies. Research work with wool has been in relation to four main points. These may be listed as:

1. Studies of methods of sampling
2. Dimensional attributes of the fiber, and the relationships these may possess to production and manufacture
3. The internal and external physical structure of the fiber, factors which influence them, and their relation to processing and type of fabrics
4. The chemical composition of the fiber and materials such as yolk and suint, and relationships to manufacture. Recently, chemical treatments of wool to render it mothproof and to give it other features (waterproofing for example) have received attention.

Features of wool fiber. The dimensions of wool fibers vary from about 0.0003 to 0.002 inch for diameter and from one to twenty inches in length during a year's growth. Crimp has been studied, and efforts have been made to determine what causes this character in wool. To date, no completely acceptable explanation has been given. Various means of classifying wool on the basis of crimp have been proposed; for instance, (a) normally crimped wool, (b) deeply crimped wool, and (c) flat or wavy wool. Crimp is defined as that property which causes wool to assume its wavy appearance. It is much more pronounced in the wool of some breeds and some individuals than others. Variation in the kind of crimp in the fiber may indicate changes in the health of the sheep and, hence, differences in the strength and other features of the fibers. The number of crimps per inch of fiber ranges from about 10 to 36 per inch. The more numerous crimp are found in the finest wools, and this has given rise to the belief that numbers of crimp are definite indica-



Courtesy U. S. Sheep Breeding Laboratory, Dubois, Idaho

These cross sections of representative wool fibers show (a) uniform diameter and shape, (b) non-uniform diameter and shape, and (c) medullated fibers. Fibers of uniform diameter, oval shape, and freedom from medullation are to be sought in breeding sheep.

tions of relative fineness. This is not strictly the case, for although there is such a general relationship, there are numerous exceptions. Coarse wool, such as obtained from Cotswolds or Lincolns, may have only one or two waves per inch. Crimp makes for great differences in the staple length and the fiber length of a fleece. Fiber length is measured by stretching sufficiently to remove the crimp. Crimp may account for as much as one-third of the total length.

Much study of the size and shape of wool fibers has been made by means of various types of projection apparatus at both low and high magnifications. For some kinds of physical studies, this apparatus is well suited. Other apparatus has been developed for the study of length, strength, pliability, and so on.

Wool fibers are seldom circular in cross-section. Most of them are irregular-shaped when viewed under a microscope or when projected onto a screen after being cross-sectioned. In studies of many wool samples at various wool laboratories, the general variations in the shape of the fibers and in their size have been universally noted. Fleeces sometimes show extreme differences in these respects, and none have been found that are completely uniform, even though the fibers are from a very restricted area of the skin.

Many writers have commented that the wool fiber is hollow, and it is through this channel that the fiber is nourished by various "juices." There appears to be no basis for such statements, for once the fiber has been elaborated it is not further changed by any activity of the body. The yolk does serve to keep it in good condition, but this is in no sense a nourishing of the fiber. The fibers have no nerves or blood supply in them. There is also a common belief that dyes enter the wool fibers through the channel which is supposed to pass from end to end. This is not the case, as fibers are readily dyed in the center without immersing either end into the dye.

Chemical composition. The chemical composition of wool is complex, and it is possible that there is considerable variation, depending upon the type of wool. The physical properties of wool are undoubtedly related to its chemical structure. Pure wool is composed in the main of keratin, which is also the chief constituent of hair, feathers, horns, and hooves. Keratin is closely related in composition to some of the proteins, but it is not identical with them, as the keratin of wool is not, at least, readily digestible in gastric juices as many proteins are. It is probable that much of the material of which the wool fiber is composed is derived from the proteins in the feeds, but these are changed in the elaboration of the fibers. Studies [1] have shown that sheep on a ration of alfalfa have deposited .15 pound of protein daily in the production of the fleece for each 1000 pounds of live weight.

While wool is represented as composed chiefly of keratin, cystine is represented as the main constituent of keratin. It is in cystine that sulphur is present in wool. The sulphur content of clean wool is about 3.4 per cent. Cystine occurs to a greater or lesser extent in most protein foodstuffs and is an essential in body growth. This has led to the investigation of the significance of sulphur in the diet, and its relation to wool quality and to wool growth. If sulphur is essential to wool production, then a deficiency would lead to a reduced weight of fleece if the percentage of sulphur was maintained, or it would lead to an abnormal fleece if the weight of fleece was maintained. Since keratin has a constant percentage of sulphur, investigators expected no change in chemical composition of wool as a result of feeding increased amounts of cystine. Slight increases in weight and slight though noticeable differences in some features of wool (glossiness) have been reported as a result of such feeding.

[1] Ill. Agr. Exp. Sta. Bul. 283.

The content of cystine in wool is exceptionally high. Marston [1] has shown that the cystine content of the proteins of plants is less than the cystine content of wool, 13.1 per cent of the dry wool fiber. Since it is unlikely that animals can manufacture cystine, their only source is that contained in their feed. Marston also states that to produce one pound of wool protein, a sheep must eat at least eight pounds of vegetable protein. It seems probable that, from a practical standpoint, cystine may be in the same category as many other substances: namely, a certain liberal allowance is needed for normal production; a deficiency reduces production; an excess does not stimulate production to such an extent as to cover the increased cost of such feeding.

In his book *A Study of the Wool Fiber,* Barker gives a list of fourteen different amino acids of which the wool fiber is composed. Presumably a deficiency of any one of these might affect wool growth, but there is no evidence at present to show that extra supplies of any one or all will greatly stimulate growth.

Since sulphur is found in wool, there have been recommendations that sulphur, even though not in the form of cystine, may be the limiting factor in wool growth. The feeding of inorganic sulphur has, however, not been found to have any tendency to influence wool growth. Certain of the other minerals are also found in the ash of wool after it is burned. These are present in very minute amounts, and it is possible that rations that are adequate for the general nourishment of sheep are also adequate for maximum wool growth. While there may be a measurable difference through the use of delicate laboratory apparatus in the amount of wool produced on rations which contain increased amounts of some minerals, the increase is below the added cost of such feeding at the present time.

Other studies have been directed toward developing an understanding of various feed constituents upon wool growth. Some astonishing results have been obtained when dietary deficiencies existed, but nothing has been found that elevates wool growth to a great extent, and nothing has been found which influences the properties of wool to a readily recognizable degree when these substances are added to an otherwise good diet.

General characteristics. Such matters as elasticity, pliability,

---

[1] H. R. Marston. The utilization of sulphur by animals; The chemical composition of wool. Council for Sci. and Ind. Australia. Buls. 33 and 38.

and softness may be influenced by environment, breed and nutrition, and individual inheritance. Studies have been made to determine how these features of the wool fiber are related to the external and internal structure of fibers. Further, it is possible that differences in the readiness with which various wools are dyed may be related to structural differences or to chemical differences.

In general, wool may be described as showing considerable variation in many of its properties. Many difficulties are encountered in research work on wool fibers because of the interrelationships one factor may have to a host of other factors. Thus, the sulphur content of wool may have a relationship to its elasticity, but other items may have equally important influences on elasticity or on some other characteristic.

Wool absorbs and holds moisture so that it is released slowly. The absorption of moisture causes some changes in the fiber, especially in diameter. The swelling of wool from an air-dry to a saturated condition may amount to almost 15 per cent. From a condition of complete dryness, the swelling would be considerably greater. Most work reported on wool fibers has been done without completely controlled conditions, and this has caused difficulty in comparing reports of various investigators. In the absorption of water, wool evolves heat. A pound of thoroughly dry wool, in changing to a thoroughly wet condition, is reported as evolving 43 British Thermal Units. This is an unusual fiber quality. Wool releases its moisture slowly.

Electricity and heat transfer through wool is slow. Undoubtedly, part of the low conductivity of heat is due to the numerous air cells which fabrics made of wool may contain. However, the conductivity of the fibers is also low.

Wool is not quickly inflammable, but it will burn and gives off a very disagreeable odor. It is very different from cotton, which burns readily. When wool is burnt, a charred bead remains where the burning has stopped. These differences serve as one easy means of distinguishing between wool and some other materials. If the material in question contains a mixture of several fibers, the so-called burning test is of no value, and more accurate chemical or microscopic means are needed. Because wool is subject to severe damage when exposed to caustics, strong acids, and high temperatures, either moist or dry, care must be used to preserve its original qualities during the scouring and other manufacturing processes

and also after it has been completely fabricated. These are the reasons why carbonizing of burry wool, for example, is a rather slow and costly process. Washing of woolen materials must be done with neutral soap—that which contains no free alkali—and the temperature of the bath must be in the neighborhood of 120 degrees F. Violent agitation of the bath is apt to cause shrinkage of a fabric or a felting tendency of unmanufactured wool.

Because of its elasticity, the best quality wool gives to fabrics a striking ability to recover from crushing or compression or from temporary stretching. When the pressure used in baling wool is released, this resiliency causes the wool to increase gradually in bulkiness. It is this property too which causes wool to "drape" becomingly on the human form and to retain the "shape" into which it is pressed when moist and is dried during the process of pressing.

CHAPTER 38

The Value of Wool

Wool is valuable because it is useful. The main uses of wool are for apparel, upholstery, carpets, and for various purposes in industry. Since apparel wools must meet the highest standards, the material here is devoted chiefly to those matters that influence its value for that purpose. Apparel wool is used fundamentally to afford protection, but at the same time it must meet requirements for style, texture, color, softness, et cetera. Wool must be able to withstand the processes of manufacture without undue waste, and the fabrics into which it is made must be durable over a long period. Many factors enter into the determination of the value of a clip of wool or of individual fleeces that make up the clip. There is, of course, the matter of supply and demand, that have an effect upon the general price level of this and other commodities. The factors which influence the supply of wool are those which influence sheep raising in general. The factors responsible for the increases or decreases in demand are the responsibility of the economist. This does not, however, relieve the student of sheep and wool production from all responsibility of knowledge regarding demand. Through the development of competition from other fibers, such matters may become of more and more importance. But here the concern is with those matters that are directly associated with wool.

Features of good wool. The best wool is the most valuable. There are certain requisites of good wool. Good wool must first meet the requirements for a certain class and grade. To do this it must have definite degrees of fineness and meet the standards for length. Besides these, good wool has strength, purity, character, uniformity, softness, and color. Present to a high degree, these give wool good working properties. A reasonable amount of grease and foreign material is permissible in grease wool, but this does not particularly influence the value of the wool fibers after they are

cleaned. It does, however, exert a great influence on grease prices, as these are the chief items in shrinkage.

Shrinkage. Shrinkage varies widely in different fleeces. It is greatest in those fleeces which have the greatest amounts of dirt and grease in them. In exceptionally clean fleeces the grease and foreign materials may not amount to more than 20 or 25 per cent, while in others that are high in grease and dirt these matters may account for more than 75 or 80 per cent of the weight of the wool. Most wools shrink from 50 to 65 per cent. The Tariff Commission reported in 1942 that the shrinkage of fine-wool in the farming areas averaged 62 per cent, ranging from 56 per cent in Tennessee to 66 per cent in eastern Kansas and Nebraska. Half-blood wool in the same area averaged 56 per cent in shrinkage, and three-eighths blood showed an average shrinkage of 47 per cent. The average shrinkage for quarter-blood wools for the farming areas was given as 43 per cent. Range wools shrink more as a rule than farm wools. This is explained by the fact that farm wools are coarser (such wools shrink less than the finer wools) and also by the fact that farm sheep are raised under conditions of relatively little dust, compared with some of the range sections. Two fleeces or two clips of wool may have the same value per pound when scoured but because of differences in shrinkage would have very different values in the grease. There are many tables showing the relative values of scoured wool and of similar wool in the grease with various shrinkages. All of these are based on the scoured value multiplied by the percentage yield, which is obtained by subtracting the estimated shrinkage from 100. Thus wool that is worth $1.05 per pound clean, but shrinks 60 per cent and yields 40 per cent, is worth $0.42 per pound in the grease. That figure is, however, not the actual price that would be received in a particular locality, for there are transportation, handling, and scouring costs that would enter into the final price determination; but the example does show the influence of shrinkage on value.

Conversely, the cost of the wool on a clean basis may be calculated from the grease price and the shrinkage. In this case the yield (100 minus the per cent shrinkage) is divided into the grease price. The result is the clean price.

The determination of shrinkage is an important matter, for it has a considerable effect on the amount paid for wool. Most shrinkages are estimated by buyers, and while many of them can

estimate shrinkage as accurately as estimates can be made, an actual determination would be far better than an estimate. In recent years efforts have been made to develop methods for the quick determination of shrinkages. Most of these are based on scouring a sample and applying the result obtained to the entire lot. Sampling methods have therefore been studied. Some have been based on taking a certain number of fleeces from a grower's clip, others on cutting a core by means of a hollow sampling tube from many fleeces as they are packed in the bags. It seems likely that with some refinements the latter method may at some time supersede the estimate method, as comparisons have shown it to be the more accurate. Legislation may be necessary, however, to establish such a practice because of opposition on the part of some wool handlers.

Shrinkage is influenced chiefly by the amount of dirt and extraneous material in the wool. Grease or yolk is also a factor, but the weight of grease in heavy-shrinking wools is usually less than the weight of the dirt. The amount of grease varies with breeds and individual sheep. Fine-wool sheep have the most grease, and the old-type, wrinkly, fine-wool individuals usually have more grease than those that are smooth bodied. Short-stapled fleeces shrink more than long stapled. Environment and management influence the amount of shrinkage. In areas of sparse vegetation and light rainfall, large amounts of dust get into the wool. Careless feeding may scatter a lot of chaff and seeds on the fleeces and cause high shrinkage. Lack of bedding in feed lots in the Central States makes for dirty wool on the belly and sides and hence high shrinkage.

Classes of wool. The two general classes of apparel wool are combing and clothing. There is a general impression that these wools are of two distinct uses because of differences in length, and from a very broad point of view that is correct. But strictly speaking, on the basis of actual use by the worsted and woolen branches of the manufacturing industry, that is not correct, for many wools used by the woolen industry are longer than some used by the worsted branch. Hence, wools could not be classed on the basis of use until they were used. However, wools are customarily classed as combing or clothing wools on the basis of length of staple, whether used in one or the other branch. Furthermore, from a very strict basis, clothing wools and woolen wools are not synonymous, as a considerable amount of the wool classed as clothing is used in the worsted industry. Woolen wools would be those wools

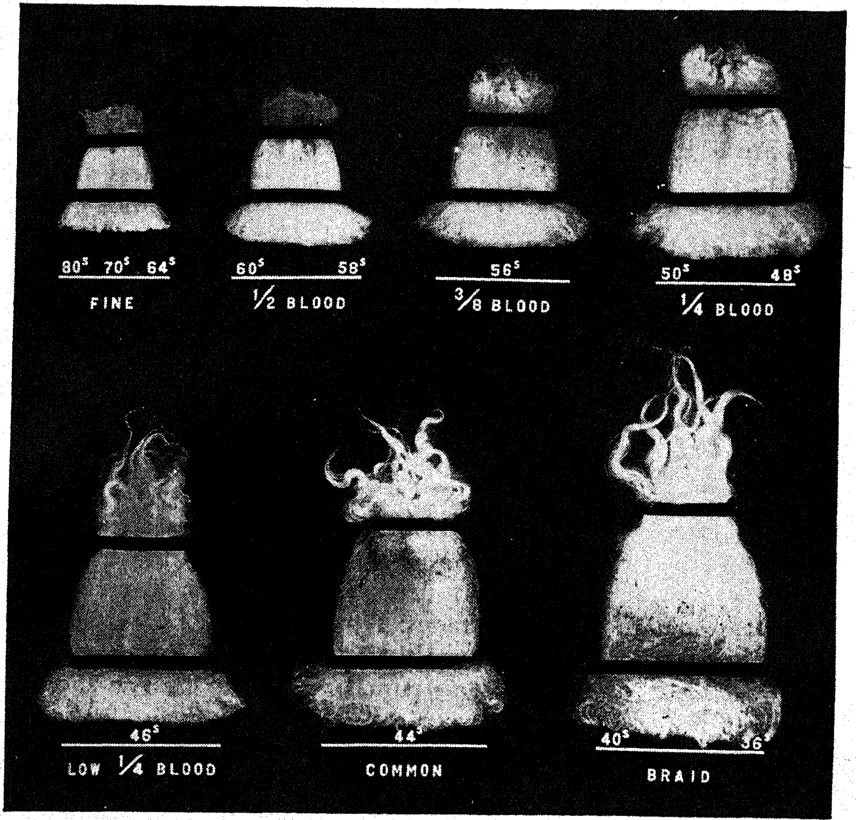
actually used for the production of woolen rather than worsted goods.

The two types of fabrics—worsted and woolens—have very different qualities. Long-staple wools are much less wasty in combing than shorter wools, and hence are more economical for the manufacturer. Since shorter wools can be bought for less per pound than long wools, the shorter types are more widely used for the production of woolens, which are usually cheaper than a comparable grade of worsted fabric. A manufacturer can get a greater yardage from a given quantity of combing wool than is obtainable from an equal weight of short wool. Before the war approximately 70 per cent of the apparel wool used in the United States was used in the worsted system of manufacture.

Fine-fibered wool should be at least two inches long for combing, but if it is longer—possibly even four or five inches—it is still better. As the wool increases in coarseness, it must also increase in length to be combed. Fine wool that is less than two inches long may be combed through the use of French combs, which are capable of handling shorter fibers than the so-called English combs. This is the basis of the intermediate classification of wool into French combing. But fabrics made from wool classed as French combing may have more of the characteristics of those made from clothing wool and hence are less valuable than strictly combing-wool fabrics. Also, since the shorter-stapled, French-combing wool may show a greater percentage of noils than combing wool, it is less valuable. Manufacturers often weave fabrics from both combing and clothing wools, as when the warp yarns are made from combing wool and the filling or weft is made from clothing wools.

The wool grower should be interested in the length of the wool which his sheep produce for two main reasons. Long staple is more valuable than short. Sheep with long staple shear greater amounts than those with short staple. There are individual exceptions, but these two matters should not be overlooked in developing a heavy-shearing flock.

Grades of wool. Grades of wool are based on fineness. Fine wools make finer fabrics than coarse wools. Fabrics made from the former are more desirable and more valuable than those made from coarse wool. Hence, fine wool is worth more than coarse wool. If this is not the case, then there is a temporary oversupply of fine wool, and there have been few times when fine wool sold for lower



Courtesy Production and Marketing Administration, U.S.D.A.

The seven standard grades of wool are designated by the usual American (blood) terms or by the corresponding numerical terms.

prices than coarser grades. These statements refer to clean wool. In that state, class and grade are the two most important items affecting value. In the grease, fine wool may sell for less per pound than wool of coarser grade, but that is due to factors other than grade.

The determination of the grade of wool is of such importance that it constitutes one of the first steps in marketing. Not only is that the case, but the first step in manufacture is a separation of the fleece into small parts on the basis of variation of fineness within it. This is called "sorting." Thus, grading and sorting are both matters concerned with fineness of the fibers. Extreme fineness is of less

importance than formerly, but it seems likely that fine-wool will be the most valuable for some time to come.

The grade of wool may be given in either the American or Bradford system. These systems use very different terminology, but both are based on relative fineness of wool fibers. Both systems are rather arbitrary, as they denote certain degrees of fineness, but in neither case do the terms have any particular significance either with respect to the source of the wool or as to its use in manufacture. The American terminology originally referred to the kind of sheep from which the wool was most likely obtained. The "counts" of the English or Bradford system indicate the number of hanks of yarn spun from wool of a particular fineness that would weigh one pound; or, as it is sometimes stated, the number of hanks of yarn that can be spun from one pound of such wool in the form of top. A hank contains 560 yards, but wool of a given count may be spun to a different number of hanks than the count indicates.

According to Bulletin 206 of the United States Department of Agriculture, the lower grades will not spin up to their numbers, while the finer grades will spin to a greater number of hanks than their numbers designating grades. For exhibition purposes some fine-wool has been spun to more than 200 counts. Length, too, influences the spinning count to which wool may be spun. Short wool will not spin to as large a count as longer wool. Furthermore, manufacturers rarely spin wools to their limit. Also the conditions under which spinning is done, especially the moisture content of the fibers and the skill of the workmen, influence the count that may be spun. Thus, while the Bradford count system may have certain refinements not found in the American system, it is still more or less arbitrary. It should be understood too that features other than fineness and, to some extent, length may enter into the grading of wool.

Comparable grades under the two systems, together with the usual length standards for three classes of apparel wool, are shown in Table 51 on page 423. Wool that is long enough to comb might be used in the woolen industry, but wool that is only of clothing length or less would not likely be used by the worsted industry.

There is a good deal of variation in the kind of wool that is shorn from any one breed of sheep. However, the most common grades of wool from the various breeds are shown in Table 52, a compilation which is based on Bulletin 206 of the United States

TABLE 51

STANDARD GRADES AND LENGTHS OF WOOL

Bradford	American	Approximate length in inches		
		Combing	French combing	Clothing
80's				
70's				
64's	Fine	Over 2	1¼ to 2	Under 1¼
60's				
58's	Half blood	Over 2¼	1¼ to 2¼	Under 1¼
56's	Three-eighths blood	Over 2½	1½ to 2½	Under 1½
50's				
48's	Quarter blood	Over 2¾	1½ to 2¾	Under 1½
46's	Low quarter blood	Over 3	2 to 3	Under 2
44's	Common	Practically always of combing length		
40's				
36's	Braid	Practically always of combing length		

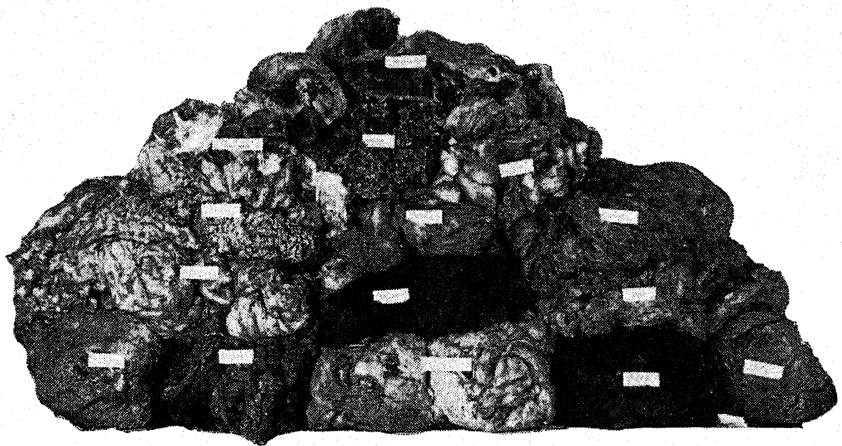
TABLE 52

BREEDS OF SHEEP AND THEIR GRADES OF WOOL

Breed	Spinning count	U. S. Grade	Class
American Merino...	64's, 80's	Fine	Clothing, some combing
Delaine Merino.....	64's, 80's	Fine (Delaine)	Combing
Rambouillet.......	60's, 80's	Fine and fine medium	Combing, clothing
Southdown........	56's, 60's	Half and three-eighths blood	Clothing, combing
Shropshire	50's, 56's	Three-eighths and quarter blood	Combing, clothing
Hampshire	50's, 56's	Three-eighths and quarter blood	Combing, clothing
Suffolk............	50's, 56's	Three-eighths and quarter blood	Combing, clothing
Dorset............	50's, 56's	Three-eighths and quarter blood	Combing, clothing
Cheviot...........	50's, 56's	Quarter and three-eighths blood	Combing
Tunis.............	50's, 56's	Quarter and three-eighths blood	Combing
Corriedale.........	48's, 58's	Quarter to half blood	Combing
Columbia.........	46's, 48's	Low quarter and quarter blood	Combing
Oxford...........	46's, 50's	Low quarter and quarter blood	Combing
Border Leicester....	40's, 46's	Braid to low quarter	
Romney..........	40's, 48's	Braid to quarter	
Leicester..........	36's, 40's	Braid	
Cotswold..........	36's, 40's	Braid	
Lincoln...........	36's, 40's	Braid	

Department of Agriculture and California Extension Circular 12.

As may be surmised from the foregoing tabulation of the kind of wool generally produced by the different breeds, there is consid-



Courtesy Production and Marketing Administration, U.S.D.A.

Wool which is subject to a reduction in price because of color, foreign material, or other condition is often referred to as "rejects" or "off sorts."

erable variation even within a breed. There is also much variation in the grade of wool on any individual sheep. This is the basis for the sorting process, which is one of the earliest steps preparatory to manufacture.

Many people have the erroneous impression that the various grades of wool are produced in similar amounts in the United States. There are, however, only four grades of which significant amounts are produced. Approximately 50 to 52 per cent is fine-wool. This is by far the largest of any of the grades. Half-blood wool accounts for about 14 or 15 per cent of the total, so these two grades together constitute two-thirds of the total. Three-eighths-blood wool amounts to 18 per cent and quarter blood, to 13 per cent. Thus, only about 3 per cent of the wool grown in this country is low quarter blood, common, and braid in grade.

The United States Tariff Commission in 1942 issued a statement that farm or fleece wools amounted to 91,000,000 or 24 per cent to the United States clip, and that 78 per cent of this was three-eighths blood or coarser in grade, and was especially adapted for knitting use. On the other hand, 83 per cent of the range wool was fine and half-blood and was especially suited for weaving purposes.

Although grade is a very important matter in the determination of the value of wool, there are no such definite standards for

grade such as the pound or foot represent in the matter of measurements. If wool grades are determined in central markets, the work is done in wool warehouses by graders. Not all wool is graded at such points. Some wool handled by country dealers who gather small clips is "country graded" before shipment to central markets. This is much less carefully done than at the markets, as it may consist only of throwing out the "rejects." Thus, a considerable amount of such wool may be regraded later. Also, wool that is from a large clip that is known to be of uniform quality may be sold in the original bag. Regardless of how handled up to this point, separation of the individual fleeces into "sorts" is done by the manufacturer.

Thus, assigning a class and grade to wool on the basis of length and fineness, while important in determining value, are not complete steps in preparation for manufacture.

Strength. Strength is another matter that influences the value of wool. Strong, durable fabrics can be made only from wool that is well grown and sound. The strength or soundness of the wool fibers is largely dependent upon the health and nutrition of the animals. Certain other environmental factors may affect the strength of the fibers. Sheep that remain in good health and that have regular nourishment, both with respect to quality and amount, are able to maintain a uniform growth of fiber and hence have sound fleeces. If the nourishment is suddenly reduced or radically changed so as to affect the health of the sheep, the fibers are weakened and hence reduced in value. If the condition of health is seriously affected, the fibers may be so severely weakened that the sheep will lose the entire fleece. This loss occurs a few weeks after the onset of the sickness. Most feeds fed in reasonable amounts do not adversely affect growth or soundness of the fibers. Any feeds fed so as to disturb the health will result in weakened fibers. Ewes nursing lambs, especially if on dry feed, do not grow as strong wool as at other times.

Some extraneous materials, such as dust, that contain considerable alkali may damage the fibers and reduce their strength. The tip and weathered area of the fleece, especially along the back, may be weakened. When the fibers are subjected to stress by pulling a strand with the fingers, and they part at a certain place along their length, the defect may be described as "tender wool." If the defect is so pronounced as to be visible, it may be described as a "break"

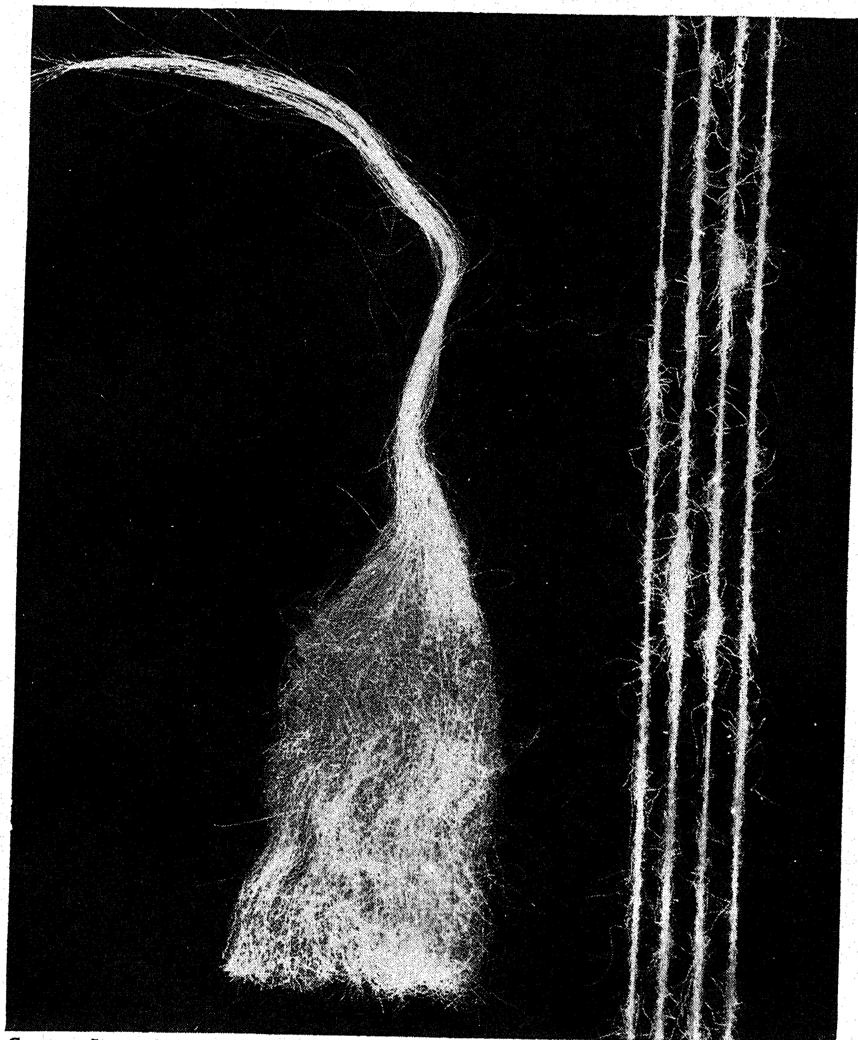
in the fleece. Such defects reduce the value of the wool because of the wastage in manufacture and because the strength of the fabric is lessened, compared with the strength of a fabric made from thoroughly sound wool. Wool graders test the fibers for strength. A small strand of fibers twisted and plucked when drawn very tight has a metallic sound. Barker [1] reports that a square inch of wool has a tensile strength of 17 tons, which is within one ton of being equal to copper wire annealed. Wool that has sufficient length to be called combing may not be so classed if weak so that it will break under the stress of being "worked."

The maintenance of health and the provision of adequate nutrition in both quality and quantity are the producer's best means of developing sound fleeces on his flock. An even, distinct crimp is one indication these conditions have been met.

Elasticity. Elasticity is an outstanding characteristic of the best wool. In this respect wool is very different from most of the other fibers. Most wool that is sound has a satisfactory amount of elasticity, although fine wool that has a distinct crimp is usually more elastic than the coarser wools. Because of elasticity fibers and yarns have the ability to withstand the strain of manufacturing processes, and fabrics made from such fibers retain or regain their shape better than if made from fibers of low elasticity. Under certain conditions wool is almost perfectly elastic; that is, it has the capacity to be elongated to a very great extent and then regain its original shape and length when the stress causing the elongation is removed. If the stress is applied suddenly or is too great, the fibers break. Various external factors, such as atmospheric humidity and temperature, influence elasticity.

Softness. Softness varies greatly in wool. In general, fine wool is softer than coarse wool, but there is much variation within wool of the same grade. The wool of some breeds tends to be softer than that from others, but there is also much individual variation within breeds and, in some cases, great differences within a single fleece. Wool that is lacking in softness is said to be harsh or wiry. It is likely true that external factors have some influence upon this characteristic. Softness is essentially the sensation which feeling of the fibers produces. Softness is of course associated with a great degree of flexibility in the fibers. If the fibers are stiff, the wool lacks soft-

[1] S. G. Barker. Wool, A Study of the Fiber. His Majesty's Stationery Office. London. 1931.



Courtesy James O. Grandstaff, U.S.D.A.

This is a lock of Navajo wool showing undesirable features: left, the outer fibers are long and coarse and there is much kemp; right, hand-spun yarn from the lock shows kemp fibers protruding from the yarn.

ness. Somewhat finer yarns can be spun from soft wool than otherwise similar wool that is harsh. Softness contributes greatly to the comfort of wearing a garment, and hence this is a very important

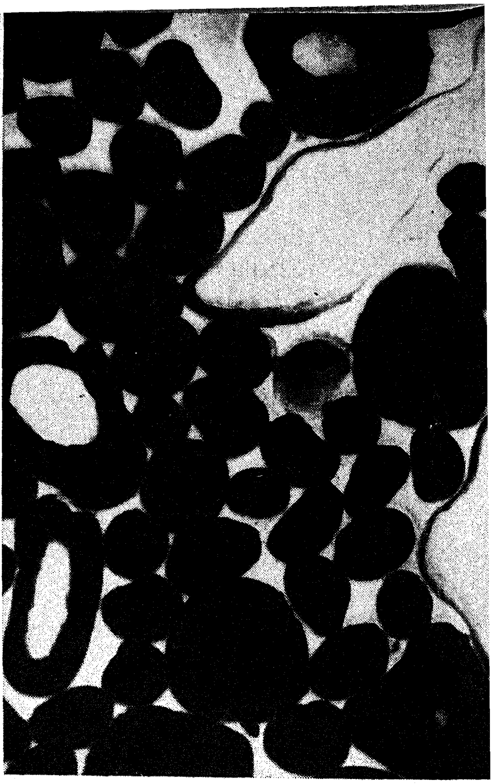
property of good wool. It is seldom that wool is reduced in price when in the grease because of pronounced deficiencies in this factor.

Purity. Purity in wool is related to the kind and color of the fibers of which the fleece is composed. Kemp is the most important of the purity defects. Kemp has practically no tensile strength and does not absorb dyes. Most kemp fibers are chalky white, although it is possible that if kemp fibers exist in black wool such fibers are pigmented. Kemp is largely, if not entirely, a matter to be eliminated by breeding and selection. It is easily seen why it is so objectionable in wool. Some novelty-type fabrics feature kempy wool, but they are not so advertised.

Another type of purity has reference to the purity of color. Black fibers in wool may be called an impurity. They are of course objectionable because wool which contains them must be dyed dark shades. Such pigmented fibers are found chiefly in the dark-faced breeds. From the standpoint of the elimination of this difficulty, it would be preferable to have all breeds white-faced. It is doubtful if black fibers will ever be eliminated from the fleeces of very dark-faced breeds. Sheep breeders are, however, likely to value the breed color markings of more consequence than the production of superior wool. This is especially likely to be the case on the part of the show breeders who seem to set the standard for the breeds until the commercial breeders rebel against such fads. In this matter of fiber color there are all degrees from a very few fibers scattered throughout the fleece to complete black. Black fleeces sell at discounts at all except special instances.

Color. Color is partly tint or luster or brightness. White wool is preferable to any other color. As stated, black fibers are an impurity as well as a color defect. White wool that is also bright or lustrous is preferable to white wool that is dull. This is possibly a matter of tint, as some wools have a yellowish cast. Bright white wool can be used in its natural color, or it can be dyed any desired shade.

Crimp. Crimp is often emphasized by some as being a very important feature of wool. The number of crimp per inch is usually associated with fineness of fiber, but this is not necessarily always the case. Wool fineness cannot be judged on the basis of crimp alone. Some Australian wool has a "bold" crimp but is finer than other wool that has a closer crimp. Crimp is related to elasticity and



Courtesy James O. Grandstaff, U.S.D.A.

Left, this is a hand-woven rug from the yarn shown on page 427. Because kemp fibers appear undyed on the surface, such fibers are objectionable in high-quality fabrics. Right, this is a cross section of the fibers shown on page 427 illustrating the extreme variation in size and shape of the fibers and the large medulla of kemp fibers.

some other features, but its chief value is probably in the fact that an even, distinct crimp indicates a well-grown, sound fiber of uniform diameter and length. The other features of good wool are enhanced and made more evident by such crimpiness.

Uniformity. Uniformity is sought but never achieved in wool. No fleeces are entirely uniform in the size (diameter) or in the length of the fibers. Fiber diameter varies widely in different parts of a fleece, and in many fleeces adjacent fibers show large differences. Furthermore, there are fleeces in which the diameter of the fibers varies from the base to the tip. This is probably due chiefly to differences in the level of nutrition and health. All of these variations are undesirable, as they increase the wastage in manufacture and reduce the value of the fleece.

It is more difficult to see the differences in diameter than in

length, but anyone who examines a fleece on the side of the shoulder and also at the breech will very likely notice the difference in fineness. Lesser differences are found in other parts of the fleece. It is also a comparatively easy matter to train the eye to see differences in size by carefully examining single fibers. Of course, the smaller the differences the more difficult it is to detect them. By starting with the larger variations smaller ones are soon noticed. Various means may be used to verify the size of the fibers. Length is easily measured. Diameter may also be measured by means of a microscope, calipers, or a projector. In extreme cases coarse, long fibers in a fleece may be twice or three times as long as shorter fibers, and the coarse fibers may have several times the diameter of the finer ones. Fleeces of such character are really of carpet-wool type. Few are found in flocks where any care is used in the selection of breeding animals. They are low in value.

CHAPTER 39

Wool Marketing and Manufacturing

Many steps are involved in getting wool from the producers to the consumers. Production may be considered as ended when the fleeces are removed by shearing. Shearing may therefore be considered as the first step in marketing, although some wool is sold before it is shorn from the sheep. Much wool is also sold on markets as the lambs are sold for slaughter, and the value of the fleeces which they carry is an item of importance in determining their values. For the most part, however, marketing is a complex process, and even if wool is sold at the time of shearing, there are many different channels and processes through which it may pass before it reaches the consumer. No wool passes through all of the marketing agencies, but all wool passes through one or more of them.

Shearing. Shearing is work which requires considerable skill if it is done well and quickly. In most areas shearing is done by professional workers who do little else; in farm-flock regions shearers may be farmers who have acquired skill and equipment and who take time from other duties to shear the flocks of a community. This is often possible without too much interference with other work because shearing is a seasonal matter. Most shearing is done in the spring after the weather has become fairly warm. This is the best time, as sheep need protection from cold rains and snows for some time after their fleeces are removed. Severe losses are sometimes experienced by those who are careless in this respect. There is, however, no exact time when sheep must be shorn, as the work may be varied, depending upon weather and other conditions. In general, shearing is easiest to do if the weather has been warm for a few days so the yolk is soft and free in the fleece. This condition makes the shears work better, and they do not become "gummed

up" in a short time. In cold weather shearing heads are hard to get through the fleeces because grease and dirt collect on the combs and cutters. In the Corn Belt states shearing is done about the same time as corn planting—approximately the first part of May, but in recent years there is a tendency to advance shearing, especially where shelters are available. In the range states shearing begins about April in southern sections and progresses northward. Most shearing is completed in the northwestern range areas during late June or in July. In these sections shearing is generally done before the sheep leave the spring grazing areas for the summer ranges. Usually, this permits shearing nearer a shipping point and hence reduces transportation charges.

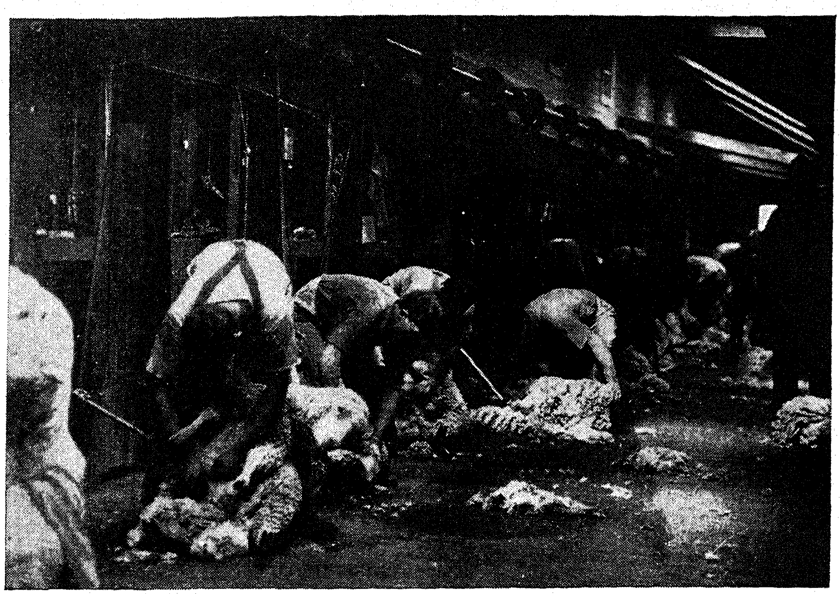
If shearing is done too early, the work is not only harder to do than if done later, but the fleeces are apt to be lighter in weight because of the lack of yolk. Where wool is sold on a basis of actual shrinkage, this is not now as important as in former years. If shearing is delayed too long the sheep not only become uncomfortable (although probably much less so than is generally suspected), but the fleeces may become taggy with locks of filth, especially in ewes recently lambed. Some producers believe they gain by having the ewes shorn before they lamb. To do this requires careful handling by the shearing crew, but shearing shortly in advance of lambing is very helpful to the lambs. Further, the wool produced by ewes that are nursing lambs is often lacking in strength compared with that which is grown at other times. Long-delayed shearing causes the wool to have a "lifeless" condition. Excessive delay may result in the loss of a portion or all of the fleeces of some members of the flock, although wool is generally not shed like hair of other animals. Close shearing and exposure to intense sunshine may cause the skin to blister. There may also be great annoyance from flies if shearing is done in midsummer.

Power-driven shearing machines. Power-driven shearing machines have now replaced most of the hand shears. There are areas however where hand shears are still widely used, and there are owners of flocks who dislike machine shearing because the wool is generally cut much closer to the skin than with hand shears. In general, the machine shears do a smoother job than the hand shears, and the fibers are apt to be cut so they will have more uniform length in the fleeces, if the fleeces have uniformity of fiber length before shearing. Sheep may be cut badly by either method

if the operators are not skillful and careful. Many sheep are permanently reduced in value at shearing time. An example of this is when the ends of the teats of ewes are cut. Skillful shearers may shear hundreds of sheep without cutting any of them severely. Beginners do much better work with power shears than with hand clippers.

Good shearing. Good shearing requires that the sheep be handled carefully and that it be uninjured when the work is completed. Sheep struggle to free themselves when they are restrained for shearing, but skillful shearers hold them in such a way that they struggle very little, and what they do is ineffective. Large, heavy rams are especially hard to hold and shear. Good shearing also means that the fleece has been removed without damage to it. One of the worst faults of shearers is the making of "second cuts." These are necessitated when the first cut is made some distance from the skin, and a second cut is made to remove the lower parts of the fibers missed by the first cut. These fribs are waste or noils in manufacture, and, except for the appearance of the sheep, might better be left on. Fleeces shorn by good workmen are not torn apart but are in one piece so that they may be easily tied into attractive bundles.

Other requirements of good shearing are that the work be done when the fleeces are dry, as damp wool is likely to mildew and the fibers become weakened or rotted. A clean place should be chosen so that no more dirt or chaff than is already in the wool will become entangled with it. In important areas where there are large flocks, it is not unusual to find specially designed shearing sheds. Most of these have provision for a number of men to shear at one time. Power is supplied by a central plant, and the shearing equipment, while individually controlled, is all run by means of one shaft. The more modern of such plants have elevated shearing platforms which the sheep reach by being driven up a ramp to catch pens provided for each operator. The sheep are kept in these pens by means of a double swinging gate or by a burlap cloth stretched across the pen just back of the shearer. Helpers, often called "wranglers," catch the sheep in the pens and place them in position for the shearers. As each sheep is finished, it is turned into a pen by means of an inclined chute or passes from the shearing floor by some other means. For the most effective operation all parts of the plant must be operated at proper speed. The fleeces



A shearing crew on a western sheep ranch use power-operated shears.

are moved away to adjacent parts of the plant for removal of tags, tying, and sacking.

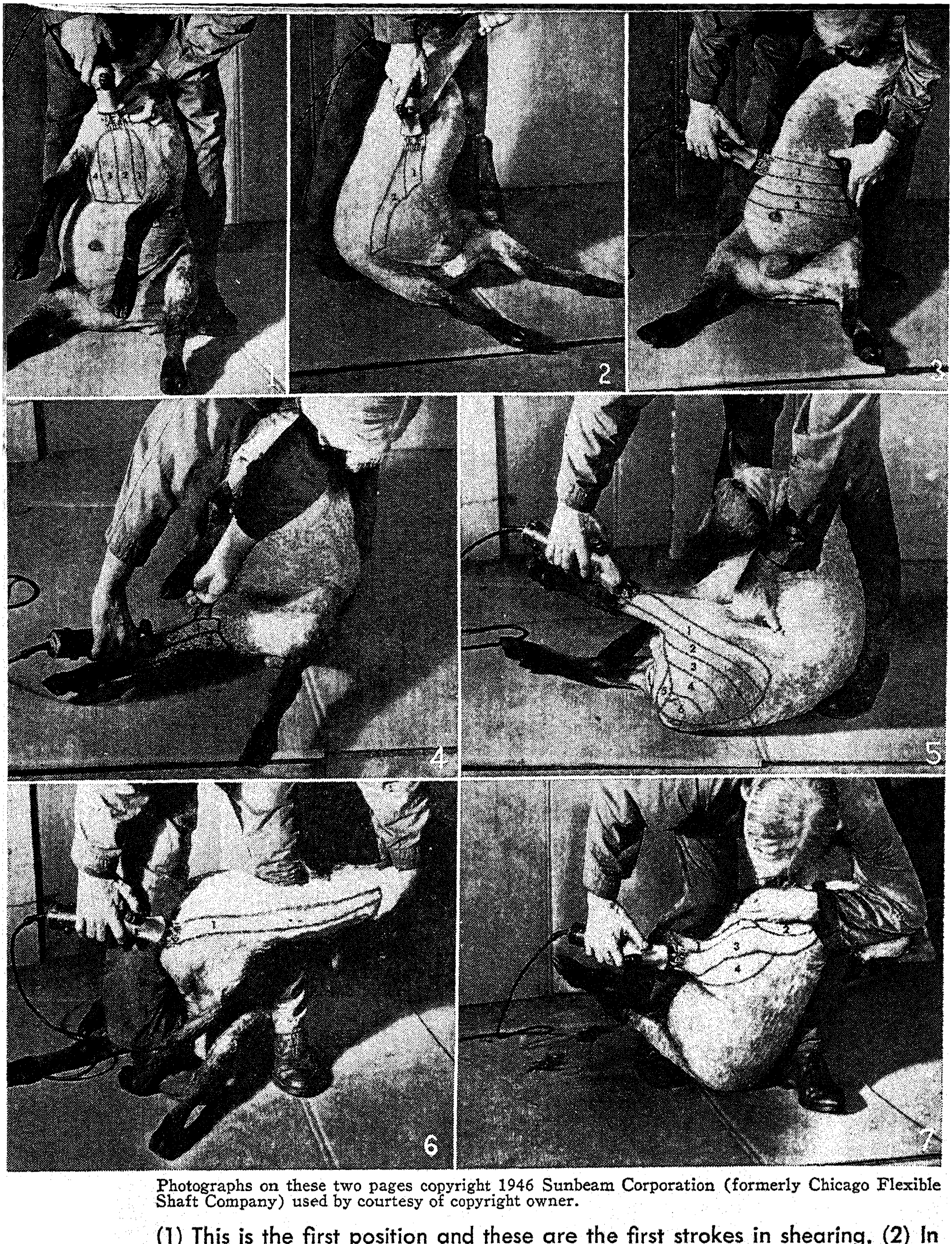
Where such space is not provided, shearing is often done on a canvas spread on the ground, or it may be done on short, clean grass. Many portable shearing outfits operate in this way. Shearing tables are sometimes used by men who shear with hand clippers. Straps are sometimes used to tie the sheep down on its side to the table.

Directions for shearing. Directions for shearing sheep by any method are helpful if they are carefully and fully studied. Practice under the guidance of an expert operator is, however, the best way to learn how to do this type of work. Even among professionals there are differences in methods; but it is generally agreed that the method employing the so-called "long blow" is the equal of any other, and it is superior to most. Those who object to it do not fully understand it. The long blow consists of several strokes from the dock area along the back to the back of the head. This enables the shearer to do a very rapid job on the main part of the body, and the total time required to shear a sheep is only a few minutes. It is a mistake to assume that all professionals are good shearers.

The long blow may leave shears marks along the back that are not so neat appearing as those that pass around the body. The following suggestions for shearing sheep by the long-blow method are adapted from directions prepared by E. S. Bartlett, who for many years has been technical advisor and demonstrator for the Chicago Flexible Shaft Company. The success attained by the operator in using the method depends largely upon how the sheep is held and how the handpiece or shearing head is held in relation to the skin. The comb of the shearing head must follow very closely the outline of the sheep. The sheep must be held so that the part of its body being sheared is easily reached by the operator, and the skin must be kept tight on that area. The free hand may be used back of the shearing head to help tighten the skin, but it must never be used to pull up on the unshorn wool, for this is certain to result in bad cuts in the sheep and also endangers the hand of the operator.

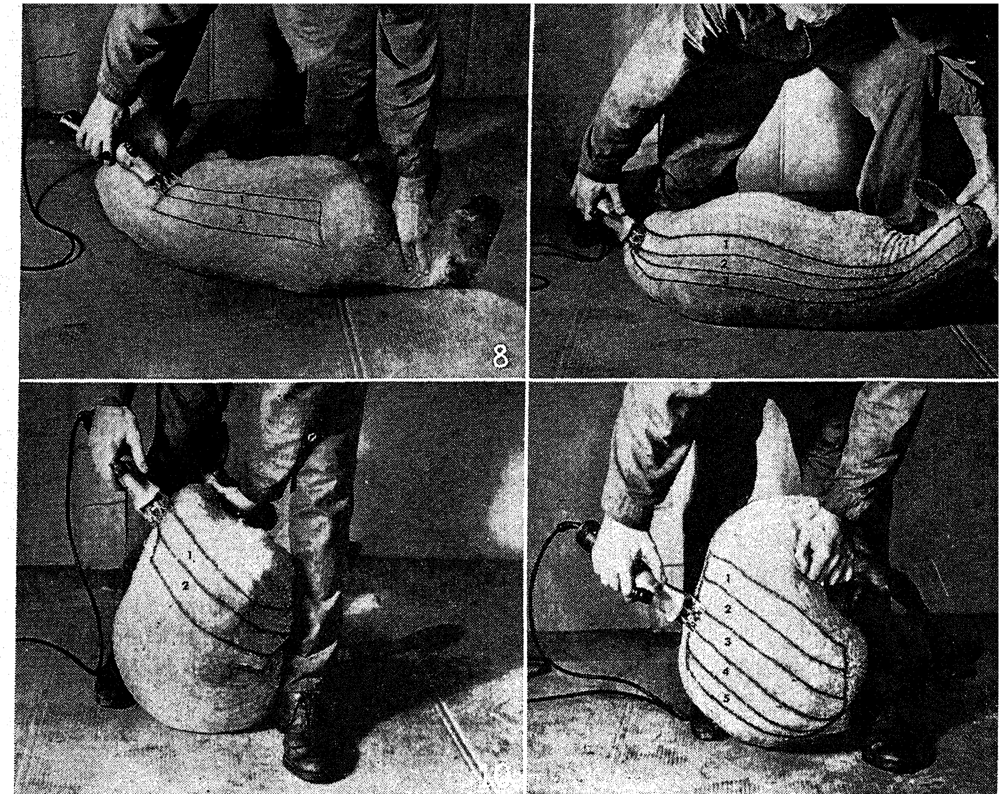
First set the sheep on its rump. This must be done carefully to avoid turning the hindlegs backward, or otherwise twisting them. It may be done by grasping the sheep underneath the neck with the left hand and reaching over the back to its right flank with the other hand. As the front of the sheep is raised, the rear is rolled around toward the holder. When properly done, the animal sits down easily and is in position for shearing to begin. An important item which is frequently overlooked is that of placing the sheep in the proper position with relation to the shearing shaft. All sheep to be shorn should be placed in the same position when the jointed shaft machine is used; otherwise, there will be times when some parts of the sheep are too close or too far away for the operator to work efficiently. This is one of the adjustments that good shearers watch constantly, and the beginner should have someone who knows demonstrate this position. After that, the beginner should try at all times to fix thoroughly in his mind what steps are the most efficient for shearing each particular area of a sheep; and he should strive always to be more efficient with respect to all operations. There is a great knack in holding the sheep in various positions, but the relation to the machine should be kept in mind with respect to all positions.

One of the greatest errors that those who try to learn to shear sheep make is that of going ahead in any way "just so the wool comes off" rather than trying to learn the best way, so that after a time they will be able to do a thoroughly satisfactory job without



Photographs on these two pages copyright 1946 Sunbeam Corporation (formerly Chicago Flexible Shaft Company) used by courtesy of copyright owner.

(1) This is the first position and these are the first strokes in shearing. (2) In this second position as in all others the skin on the area being shorn is kept tight. (3) The belly is sheared around from right to left. The left hand has important work here, too. (4) Shearing the inside of the hind legs is one of the parts requiring proper position and careful work. (5) This is the best position for shearing the left thigh, hip, and about the dock. The left hand



pressed in the flank keeps the leg straight. (6) Note the position of the operator's feet and legs as the sheep is kept under control and the skin on the lower part of the neck is stretched tight. (7) A few small shifts bring the sheep's left shoulder into shearing position. (8) the position of the feet here is important. The operator's right foot is between the sheep's hind legs and his left foot is under the right shoulder. (9) This is the proper position of shearer and sheep for the "long blows." (10) After shearing the right side of the head and neck the sheep is "rolled up" to shear its right shoulder. (11) Here the operator has a large area for fast work. (12) The sheep's head is brought back on the right side for the last few strokes to finish the job.

more than the necessary amount of exertion. Another matter is the importance of taking long, full strokes and following the contour of the sheep. Short, little jabs take far too much time, and second cuts made necessary by not following the sheep's body closely not only reduce the value of the fleece but also increase greatly the time required to complete the work.

There are really twelve main positions in shearing. Hold the sheep so it cannot struggle effectively. Expert shearers seldom have any difficulty with struggling sheep. The position of the shearer's legs, feet, and hands are necessarily changed as he changes areas being shorn. This is necessary so he can keep "on top of his work." These directions cannot be more than guides, but they will be helpful if used together with a very careful and repeated study of the illustrations.

First, shear the brisket to just below the forelegs. Then pull up hard on the right foreleg, push slightly with the left knee against the left side of the sheep, and shear from the lower right side of the brisket to the right flank. Then shear around the belly from the edge of that stroke. Keep the skin tight and smooth and avoid cutting the sheath of rams or the teats of ewes. These strokes used in shearing the belly end about on a line with the left stifle and elbow joints.

Next, shear the inside of both hind legs. Straighten the legs by pressing on the stifle joint; never take hold of the foot. Take the first stroke outward on the right leg, then shear toward the body and around the crotch. Step slightly to the right and let the sheep "fall" into position.

Then, shear the outside of the left leg and the left hip. The sheep rests on its right hip while this is done.

Follow this by shearing the neck, after the sheep has been straightened up, and the neck rests against the shearer's left leg above the knee. This is a hard place to shear. The opening stroke is started at the brisket, passes below the ear, and ends at the face. Shear all of the neck except the top and right side, also the head except the right side.

Then, shear the lower part of the left shoulder.

The sheep is now placed on the floor on its back and right side, but its feet are kept off the floor by the shearer placing his left foot under the sheep's right shoulder and his right foot between the hind legs. The left foreleg is pushed toward the sheep's head.

The left side is then shorn with strokes from the rear toward the front. As shearing proceeds from the side toward the back, the sheep rolls farther onto the right side. These long strokes are the ones which enable the worker to do some very fast shearing and are the basis of the system known as the "long-blow method." Shearing in this position is finished when a stroke has been made to the right of the backbone.

Next, the shearer's right foot is moved over the back of the sheep, and he is in position to shear the right side of the head and neck. The left foot must be kept under the shoulder to prevent the sheep from getting to its feet. Lift the head and shear the right side of the face. Step back slightly and gradually roll the sheep upward onto its rump as the neck is sheared.

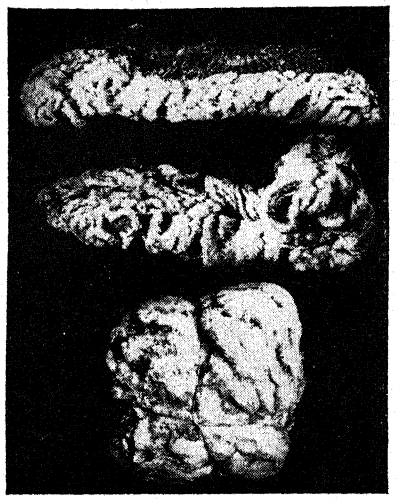
Shear the right shoulder and right leg. The head of the sheep is held over on its left side to keep the skin tight where the shears are operating.

Shear the right side with strokes from the back to the right edge of the first shears stroke down the right side of the belly. These strokes can be made very quickly if the sheep is in proper position.

When the right flank is reached, the head is raised so it is in front of the operator's legs. He moves slightly to the left so he can reach the outside of the right leg, which is shorn with strokes from the flank region while the leg is straightened by pressure on the stifle joint. The skin is tightened with the left hand, as the right thigh and region about the dock is shorn. The job is then complete.

These directions are incomplete and brief. The intent is not to give detailed instructions for shearing, which can best be learned by working as an apprentice under the guidance of an expert, but to emphasize the fact that there is a widely accepted standard method for doing the work, and that there are many items which must be watched if skillful, rapid work is to be done. Shearing is the harvesting of one of the most valuable products per pound now regularly produced on American farms.

The number sheared. The number sheared in one day will depend upon a variety of conditions. First, of course, is the speed at which the operator works. But the size of the sheep, the extension of wool over various parts of the body, the completeness with which the lower parts of the legs and face are sheared, the condition of the skin with respect to wrinkles or folds, and the condition of the wool are all important factors in this matter of the day's tally.



Courtesy University of Illinois

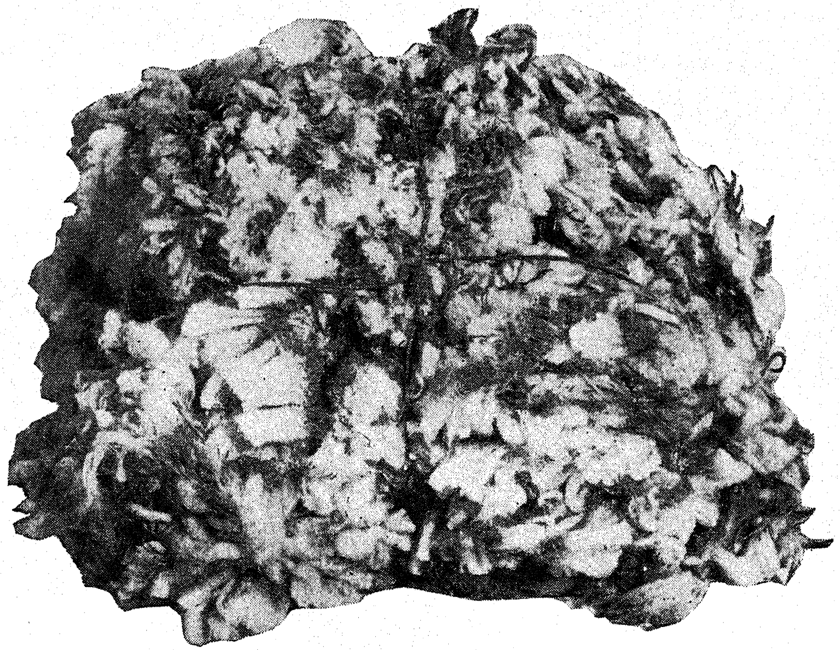
Wool tying is often poorly done. The correct method consists of these steps: top, the fleece should first be spread out, flesh side down, and any tags removed; center, the sides are turned over on top, and the fleece is then rolled starting with the rear parts; bottom, the fleece is then tied. Seven to nine feet of paper twine is ample for most fleeces.

Those men who are not mechanically adapted seldom become good shearers and may not be able to shear more than 50 or 75 in a day. Others may do superior work and shear from 100 to 200 daily, and some have far exceeded these numbers. Bartlett[1] reports in his very interesting treatise on shearing that 100 Rambouillet ewes were shorn in 3 hours 38 minutes. He reports 356 in 10 hours with hand shears. Sheep and conditions differ so greatly that a performance in one section may be very unlike that of any other section.

Tying the fleeces. Tying the fleeces individually is generally practiced in this country. Wool-tying boxes are sometimes used, but they are entirely unnecessary, although they may aid in cases where the fleeces are very short stapled and badly torn apart in shearing. Good fleeces properly shorn are readily tied by merely turning them over so the skin side is against the floor. Spread out in this way, the tags are removed for separate packing without tying, and the leg and belly wool is folded over toward the center of the fleece. Folded in this way, the fleece will be about 18 or 24 inches wide. The fleece is then rolled, beginning at the rear and rolling towards the front so that the shoulder wool will be on the outside. A piece of paper wool twine about seven feet long is ample to tie most fleeces. The twine is wrapped around the fleece and then crossed and wrapped in the other direction. When pulled reasonably tight and tied with a knot that will not slip, the task of tying is completed.

Special emphasis should be placed on the matter of twine, for

[1] E. S. Bartlett. Sheep Shearing, Breeder Publications.



Courtesy Production and Marketing Administration, U.S.D.A.

This is a well-grown, carefully sheared, and properly tied fleece.

much wool is tied with materials such as sisal that may leave pieces mixed with the wool, may later be found in the fabric from which it must be removed by hand, and may leave an imperfection in the material. Campaigns by various agencies have reduced the use of such twine, but there are still producers who fail to heed the recommendations. Improperly tied wool is now subject to a price discount.

Packing. Packing the fleeces is the next step in marketing. Where the clip is not uniform with respect to grade, class, and other factors, some effort should be made to pack it on the basis of similar fleeces. Black wool (such sheep should be sold as lambs), for example, should be packed separately. Coarse wools should be packed separately from fine-fibered wools. In large flocks ewe, ram, and lamb fleeces are best separated. Wool is packed in bales in many countries, but in the United States it is generally put into large sacks made for the packaging of wool. The upper end of the sack is supported by a ring which holds it open so the fleeces may be

Courtesy University of Illinois

Packing fleeces is an important step in wool marketing.

tossed in. The fleeces are tramped firmly by someone getting into the sack. The weight of wool put into a sack depends upon the kind of wool and how firmly it is packed. Thirty fleeces is about an average number per sack, and the weight may vary from about 225 to more than 300 pounds. When filled, the sack is released from the rack, and the top is sewed with heavy string. "Dog ears" at the top of the sack and also at the bottom, where they are made by tying a small tuft of wool in each corner, aid greatly in handling the filled sacks. The sacks should be turned inside out so the seam will be on the outside. This facilitates opening.

Storing wool. Storing wool is an important matter. Wool will keep for a very long time if kept clean and dry and protected from insects and excessively high temperatures. It is well to mark each sack with the kind of wool it contains. Wool warehouses are the most satisfactory storage places.

Marketing agencies. It is possible for the producer to sell his wool through a number of different agencies. The list of agencies include private enterprises and cooperative associations. Those in the first group may be divided into groups such as local dealers, state dealers, central market dealers, commission merchants, brokers, and manufacturers. Cooperative associations likewise may be local, state wide, or nation wide. There are now agencies which correspond to all of these designations. All of them may perform a similar service: that is, assist in getting the wool from the producer to the manufacturer; but the objectives may be different, and the character of the services vary widely. Testimony before a senate committee showed that five dealer organizations handled 33.6 per cent of the domestic wool in 1933 to 1935, and 25 dealers handled 72.9 per cent of it.[1] This same author states that while there are

[1] GARSIDE, A. H. Wool and the Wool Trade, p. 60. Frederick A. Stokes Co.

about 80 consumers of apparel wool in the worsted branch and 400 in the woolen branch, four of them with offices in Boston bought a total of 40 to 45 per cent of the clip.

Local dealers. Local dealers in most places handle wool only as a part of their business. Many deal in other commodities such as grain, livestock, produce, or junk, and they gather the clips of small flocks for sale to other dealers or to manufacturers. Most local dealers have little knowledge of wool quality and buy clips at a flat rate for the community. They pay cash for the wool and thus serve those whose clips are too small to be of much consequence in making up the total income of their farms. The local dealer provides little incentive for the grower to improve his clip or its preparation for market, although objections may be made to certain features of the wool offered. Many local dealers make no attempt to grade wool, although some do "country grade" it into fine, medium, burry, black, et cetera. The territory which local dealers cover may be just a few miles, or it may extend over a radius of a hundred miles or more. Most large wool growers use some other agency.

State dealers or central market dealers. State dealers or central market dealers generally operate on a cash basis like the local dealers. Their activities cover a much larger area, and of course they handle wool in much greater amounts. They may buy from growers or from local dealers and may sell to other dealers or to manufacturers. Since they have large quantities of wool, they can perform services which are beyond the field of the local dealers. Most of the wool in this country is handled by this group. They usually perform such services as grading, warehousing, and the assumption of risks arising from possessing wool in large amounts. These dealers often have buyers in all points where large clips are for sale. They of course buy at the lowest prices possible and take a chance at being able to resell at a profit. They can attract manufacturers to consider their offerings, as they have a chance of getting such qualities of wool as they require.

Commission merchants. Commission merchants perform essentially the same functions as the central market dealers except that they do not, when acting on a commission basis, buy the wool, but they receive it from the owner for sale at such time and price as sanctioned by the owner. The owner may give the commission merchant full responsibility for the sale. Many commission mer-

chants have also bought wool on a cash basis, and because they operated in two ways, there has been considerable criticism, for they may have opportunities to profit more through the purchase of a clip than through handling it on a strictly commission basis. Returns to the grower are delayed, compared with sales direct to dealers.

Brokers. Brokers are in reality manufacturers' representatives who help locate suitable lots of wool. Manufacturers may buy from any agency or even from growers if the offering suits their needs. Small mills throughout the country buy from growers within the territory. Manufacturers may buy either graded or ungraded wool. Regardless of whether or not it has been graded, the manufacturers must sort it as an initial step in processing.

Cooperative associations. Cooperative associations in recent years have handled from 10 to 15 per cent of the domestic clip. Some associations are groups of local growers who assemble their clips for sale at a set date. By so doing they are able to attract more buyers than if each sold separately, some effort may be made to have the wool graded, and other refinements may be introduced to secure increased prices. Some local pools have been in operation for many years.

State cooperatives are usually more highly organized than local pools and generally handle much larger amounts of wool. It may have more careful grading, and since the amount of wool is larger, more buyers are attracted. At present a considerable number of state associations are affiliates of one sales agency, the National Wool Marketing Corporation. There are other sales agencies serving cooperatives, but all perform similar services. The program of the National Wool Marketing Corporation, organized in 1930, may be summarized as follows:

1. Warehousing, grading, and otherwise preparing wool for sale direct to mills
2. Securing loans and advancing money to participating growers on the basis of the amount and quality of wool consigned
3. Reduction of wool-marketing expense
4. Stabilization of the wool market by selling at such times as the mills require
5. Supplying information to the grower regarding the kinds of wool he has consigned
6. Studying the possibilities of improving marketing methods

7. Promoting and assisting other organizations in promoting the use of wool by stressing its peculiar properties and its advantages

Wool to be sold by the cooperative sales agency is shipped to its warehouses. Because of the variation in the wool received, grad-

TABLE 53

PROPORTION OF WOOL OF VARIOUS GRADES RECEIVED BY 11 FLEECE-WOOL COOPERATIVE ASSOCIATIONS, 1930–36 [1]

	Fine-wool	½ Blood	⅜ Blood	¼ Blood	Low ¼	Common and braid	Black	Rejects	Out	Total
Michigan Cooperative Wool Marketing Association	31.52	12.39	16.69	18.91	4.30	1.61	0.73	12.61	1.24	100.00
Iowa Sheep and Wool Growers' Association	10.73	7.81	21.96	44.98	4.89	.17	.68	7.94	.84	100.00
Wisconsin Cooperative Wool Growers' Association	9.73	6.67	30.00	40.01	9.77	.97	.89	1.80	.16	100.00
New York State Sheep Growers' Cooperative Associations, Inc.	22.23	19.13	29.71	21.13	2.41	.40	.49	4.33	.17	100.00
Indiana Wool Growers' Association	7.48	9.09	26.39	43.94	1.90	.51	.82	9.47	.40	100.00
Midwest Wool Marketing Association	22.48	10.18	21.78	22.35	2.95	.26	.93	14.99	4.08	100.00
Minnesota Cooperative Wool Growers' Association	7.44	8.56	34.03	36.42	3.60	.27	.51	7.97	1.20	100.00
North Dakota Cooperative Wool Marketing Association	38.76	14.06	21.78	20.14	1.74	.08	.22	3.15	.07	100.00
Illinois Livestock Marketing Association	6.76	8.07	23.74	46.22	3.52	.78	.77	9.96	.18	100.00
Cooperative Wool Growers of South Dakota	24.87	12.53	21.05	30.63	1.21	.02	.49	8.39	.81	100.00
Kentucky Wool Growers' Cooperative Association	2.68	14.04	42.31	32.92	3.48	.19	1.49	2.63	.26	100.00
	17.46	10.66	25.64	31.12	3.24	.32	.72	8.94	1.90	100.00

[1] Source: Records of the associations. The receipts of the cooperatives were broken down by diameter of fiber rather than length of fiber. This was done because the grades of wool produced in an area do not change radically by diameter of fiber but do change from year to year in length of staple. Feed and weather conditions may materially affect the growth of the wool, and in some years the grades will show an unusually high percentage of clothing or short-staple wools. The common and braid grades, although contrary to the U. S. standards for grades of wool, were combined into one grade. It was considered impractical to separate the two, as they are used for the same manufacturing purposes. Black was separated from the rejects for the purpose of determining, if possible, where educational work was being conducted to reduce the number of black fibers in fleeces. The column "Rejects" includes all other off-grades such as burrys, tags, dead wools, and so forth. The percentage of rejects will vary considerably from year to year. Wet years will see more taggy wool; on the other hand, during dry seasons a greater percentage of burry wools will show up. The column headed "Out" included small quantities of wool of which it was impossible to determine the grades from the records of the associations. Although it is impossible to get the break-down of receipts by grades from the pool operations, the totals from this table might be used with a fair degree of accuracy in determining the percentage of grades of wool in the fleece-wool states.

ing into uniform lots is necessary before the wools can be intelligently merchandized and sold on their merits. Purchases may then be made on the basis of samples from each line. Table 53, on page 445, taken from Bulletin 33 of the Farm Credit Administration shows the various grades of fleece wools handled during a six-year period.

The grading and storage of wool in warehouses entails some risks which are usually covered by insurance. Storage costs vary with the length of time involved, but facilities must usually be kept available throughout the year, since the policy is to sell to mills as they have need for the wool. This policy is based on wool growers experiencing relatively low prices at shearing time, with increases later. It is on the likelihood of increased prices after shearing time, that dealers expect to make their profits. It is the aim of cooperatives to obtain some of this profit for the members. In doing so, severe competition is encountered. If the cooperatives succeed in raising the price, the non-members profit too. Hence, the statement that "cooperative agencies, if successful, create increased competition." Dealers may offer higher prices, especially for the best clips, at shearing time if the grower has the chance of using some other sales method.

Financial services are important functions of the cooperative agencies. Upon receipt of the grower's wool at the warehouse, a loan or advance of a certain percentage of its appraised value is available to him. An interest charge is made for this advance, and it is deducted later at the time final returns are made for the clip. Most agencies make final payment before the next shearing season arrives. Probably from one-fifth to one-third of the wool produced in the United States is handled by these agencies on this basis.

Marketing costs are deducted from the value of the wool regardless of how it is sold. Dealers' prices are on a basis that allows a margin to cover the various items involved. Costs vary with localities and are influenced by such matters as freight rates, grading and warehousing, charges by local associations, and charges by the national association or selling agency. Costs of marketing fleece wools cooperatively usually approximate 5 to 6 cents per pound. Costs for territory wools may be somewhat higher, due mainly to greater freight charges. The minimum carload weight for fleece wool is 16,000 pounds; for territory wool, 24,000 pounds. There are only small chances of further reducing marketing costs.

In Correspondence refer to this

GRADING SHEET

Acct. No. ____________

OWNER:

.... Lot No. ....

.... Date Graded ....

No. Bags Rec'd .... Net Graded Weight ....

GRADES	Weight By Grade	Advance Per Lb.	Amount Advanced	FINAL SETTLEMENT Price	FINAL SETTLEMENT Amount	GRADER'S REPORT
Fine Combing						Grader—
Fine French Combing						
Fine Clothing						
½ Combing						Staple
½ Clothing						
⅜ Combing						
⅜ Clothing						Condition
¼ Combing						
Low Quarter						
Braid						Color
Medium Chaffy, Seedy or Burry						
Medium Grey or Black						
Low Grey or Black						Other Remarks
Dead						
Damaged						
Cotted						
Heavy or Bucks						
Mohair						
Tags						
Pelts						
						Date of Advance
						Date of Final Settlement
TOTALS						

Inbound Freight			Total Advance Deducted from Final Acct. Sales	
Sacks—No. Charge				
Twine No. Tubes Charge				
Advance at Receiving Point Amount				
Subscription to				
Total Deductions				
Check for Net Advance No.			Check for Final Payment No.	

The other activities of the various associations are chiefly directed toward a better informed membership. Efforts to accomplish this are made at the time of meetings, through field services, market news service, and the rendering of grading and sales reports. Much market news is available through the United States Department of Agricultural Marketing Service. A full understanding of such reports requires a fairly accurate and extensive knowledge of the meaning of wool terminology and grading.

Grading reports, a sample of which is shown on page 447, are valuable sources of information to growers. This, too, requires that they understand the terminology and be able to make changes on the basis of the report. In doing this the services of extension workers are often valuable. The study of such reports will help the grower learn much about the kind of wool he is producing and the comparative values of the different grades.

There is dissatisfaction with wool-selling methods in the United States. It is said that there is no open market where values may be established by competitive bidding. Because of this, auction sales have been strongly advocated. Proponents of this method believe that it would enable producers to have better information about actual sales, and that values would be established by those who are in need of wool or who have the best outlets for it. Some auction sales have been held at which large amounts have been sold. In most sales there have been set prices, and the wool had to sell at or above that figure, or it was "passed" to be offered again at later auctions. Experience with sales or other commodities by the auction method indicates that the system will not be the final solution of the problems of wool marketing, if, indeed, there is any such solution.

Manufacturing processes. After the manufacturer purchases a lot of wool, he must pass it through many processes before it takes the form of a fabric. Even though the wool has been graded before bought by the manufacturer, he must sort each individual fleece, and from these "sorts" he obtains wool of much greater uniformity than found in the whole fleeces. The number of sorts which are made depends upon the variations found in the fleeces and the quality of the yarn which is intended.

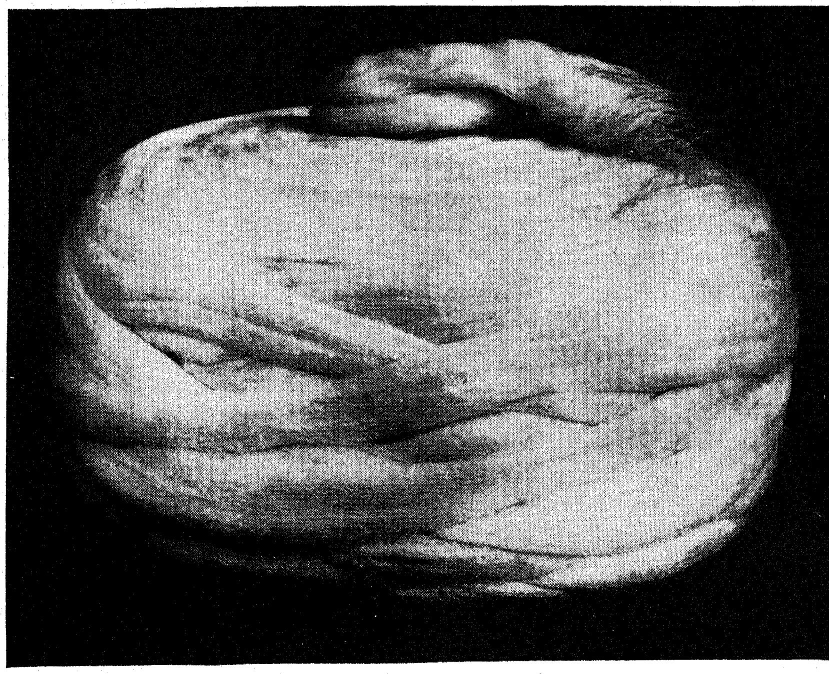
Scouring. Scouring is another step in the manufacturing process. There are different methods of scouring, but all have for their purpose the removal of the dirt and grease from the fibers


Courtesy Production and Marketing Administration, U.S.D.A.

Wool grading—one of the many steps in marketing—requires considerable training and experience.

without damage to the fibers. Care must be used with respect to the kinds and amounts of soaps or solvents used and the temperatures at which the scouring bath is maintained. Scouring machinery usually consists of a series of tanks or vats, each of which may be 30 or 40 feet long and 3 or 4 feet wide. A frequent practice is to use three vats for scouring and one for rinsing. Some wool is put through "openers" before it is scoured so the solution may act more readily on encrusted parts such as the tip. The wool enters the tanks, passes through them in succession, and is kept moving by rakes or forks, which also provide a suitable amount of agitation to assist with the washing. As the wool leaves the rinse vat, considerable water is squeezed out, and it then passes into driers. In the driers the wool is subjected to a strong current of warm air. Excessive heat must be avoided.

Carding. Carding is the next process after drying. This is done by passing the wool between cylinders which have fine wire teeth and which revolve at different rates. The wool comes from the cards in a fluffy rope-like roll in which the fibers lie in all directions. It is further processed until it is in a strand from which yarn may be spun. In the woolen industry the yarn is usually spun on a machine called a mule. This is composed of a great number of



Courtesy Production and Marketing Administration, U.S.D.A.

This is a ball of wool top. A standard product in wool manufacture is produced by the combing operation. In general, the fibers are long and lie parallel. Short fibers are combed out as noils.

parts, but its action consists of both a forward and backward movement, during which the yarn is drawn and spun and also wound on spools.

Combing. Combing is the distinctive process of the worsted industry. Much wool that is to be combed may have been carded, but the cards used are different. Efforts are to have the fibers as nearly parallel as possible before the strands of wool reach the combs, which are designed to place the fibers parallel in the strands and to remove the short fibers or noils. The combed fibers come from the machine in a long strand or sliver called top. The top is further processed by doubling and drawing until it is finally reduced to the proper size for spinning. Before spinning, the wool is referred to as roving. A different type of spinning machine is used for spinning worsted yarn than for woolen yarn. This is be-

cause the worsted roving is of small size and requires only slight further drawing to reduce it to the desired size for yarn. This can be done as it is twisted into yarn and wound.

After the wool is in the form of yarn, there is little to distinguish the remaining process of the woolen and worsted industries. Dyeing, weaving, or knitting processes are the same. Later, a nap or face may be worked on woolens, while the weave pattern is made as distinct as possible on worsteds. Woolen and worsted yarns are often mixed in weaving, and cotton and other fibers are also used with wool, either mixed in the yarn or otherwise. If such mixtures are used, their presence is required to be made known under the Fabric Labeling Act of the National Government.

Some mills perform all of the operations of wool manufacture, but many do only certain portions. Many mills may only weave and finish cloth; others make top; some spin yarn. Most of the goods made from wool are woven, but some are made by knitting. Several years ago 97 per cent of the woolen and 72 per cent of the worsted yarns were used for weaving; the balance in each case was used chiefly for knitting.

CHAPTER 40

Diseases and Parasites

This chapter is presented from the standpoint of the producer and feeder rather than from the viewpoint of the veterinarian or other professional workers interested in diseases or certain aspects of disease, such as the parasitologist might be. The problem of sheep diseases is essentially a matter of prevention rather than treatment, and the producer is concerned with diseases as they relate to various features of management, feeding, and breeding. To understand these relationships, the producer and feeder must know some of the main features of various diseases and be alert to the best means of developing management practices that will be distinct aids in preventing diseases.

Treatment of sick animals is expensive and costly even when they recover, for there are many setbacks to their development, and disease always interferes with production. Even at best, treatment is often a very uncertain procedure, for accurate diagnosis is difficult, and there are ailments for which there are at present apparently no effective treatments. Diagnosis is complicated because of the similarity of symptoms of many diseases, and even when the trouble is correctly determined the likelihood of sheep surviving is not great, for they seem to have little margin of safety in their make-up, do not withstand operative procedure well, and often fail to respond satisfactorily to medicinal treatment. Since these are the conditions so often experienced, it is easy to understand why so many producers are inclined to say "a sick sheep is a dead one."

The usual value of a grade sheep does not justify much of a fee for the services of a veterinarian, and few of them have such complete training and experience with sheep as with other animals. But the flock owner who has the services of a competent veterinarian available is often in a fortunate position, as such service may minimize losses by aiding in correcting unsatisfactory conditions. Research is continually expanding our knowledge of diseases and

their control, and while some destructive diseases are now wholly beyond the realm of successful treatment under practical conditions, many of them may be brought under control with further study.

Flock owners should be familiar with the most common ailments found in their localities, but they should also realize that diseases new to many localities occur from time to time and that a high degree of technical skill coupled with laboratory facilities is necessary for correct diagnosis and treatment. Some producers are inclined to think one and the same treatment should suffice for all diseases. Some are apt to ascribe all coughing, for example, to one species of internal parasite, but this is only one symptom associated with several different diseases. Correct diagnosis is the first essential for correct treatment, and many diseases cannot be diagnosed on the basis of one symptom.

The occurrence of many diseases is associated with feeding and management. Proper feeding, management, and sanitation are the flockmaster's best aids in disease prevention. The best feeding and management practices are relatively simple, although descriptions of them may tend to make them appear complicated and involved. Most good practices are dependent upon the provision of good quality, nutritious feeds, clean water in adequate amounts, and constant attention to sanitation. In regard to this last item, many have a very imperfect knowledge of the hazards to health that arise because of neglect in maintaining clean, dry, comfortable quarters, especially at such critical times as the lambing period. Some diseases, such as dysentery, are directly traceable to filthy conditions in the fold.

It is quite reasonable to assume that many diseases which can be cured can with adequate attention be prevented. Prevention does not require pampering, but it does involve avoiding overcrowding, giving opportunity for exercise, clean water, clean quarters, and some attention to the animal's comfort. Dirty feed racks, stagnant water, lack of bedding, poor quality feed, and many other factors are favorable to the development of disease.

Sanitation. There are several aspects of sanitation which should be emphasized. One of these relates to the hygiene of shelter and the small adjoining lots; another, to pasture sanitation in relation to many troubles associated with parasitism. Shelters are not sanitary when they are not dry and clean. A wet fleece with ex-

posure in very cold weather may lead to pneumonia or at least to heavy nasal discharge. Dampness within the shelter may have a similar effect. Closed barns are apt to lead to such conditions, too, as ventilation may be poor and dampness become pronounced. Wet or damp sheds favor the development of a skin irritation, which may lead to loss of a considerable portion of the fleece.

The accumulation of manure and wet filth in sheds and yards may lead to foot troubles, dirty fleeces which sell at a discount, and be a reservoir of infection for new-born lambs. Such difficulties as scours, navel ill, dysentery, sore eyes, and many cases of respiratory trouble are directly traceable to filth. Regular cleaning and use of an abundance of clean bedding are requisites of shelter sanitation.

Disease classification. Diseases may be classified in several different ways, as parasitic and non-parasitic, infectious and non-infectious, virus diseases, bacterial diseases, plant poisoning, digestive, respiratory, reproductive, and in many other categories. But it is not the intent or province of the author to enter into the technical aspects, with minute descriptions of the causative organisms, lesions, and so on. The purpose of this text is served by calling attention, in language which an intelligent layman can comprehend, to the great variety of diseases that may affect sheep and to point out the relationships which feeding, care, management, heredity, and sanitation may have to many of these difficulties. Indeed, many losses of sheep are not due to disease but are due to accidents, some of which are fostered by the negligent owner or shepherd. Further, some infectious diseases of animals are communicable to man, and this alone should be enough to arouse much interest in general information regarding disease prevention. The disposal of carcasses of sheep that have died from any cause is a matter of importance in all diseases. Failure to realize the importance of disposal has led to some serious outbreaks of disease. Carcasses should be burned or buried beyond the reach of dogs, cats, buzzards, and insects or disposed of in accordance with "dead animal acts" in force in the various states, or disease may be spread to neighboring farms or to a larger area.

Anthrax. Anthrax is an infectious disease, not only of sheep but of other animals and man. It runs an extremely rapid course and usually terminates in death in from a few to 24 hours. In areas where anthrax has occurred, extreme care should be used in handling any sick animals, and veterinarians should be called. No ef-

fort should be made to salvage the pelts of dead sheep in such areas. All carcasses should be burned or disposed of in some manner to eliminate the danger of the spread of the trouble. Pastures where sheep have died of anthrax may be dangerous for a long period.

Tetanus. Tetanus (lock jaw), which is caused by an organism, usually follows such operations as docking, castrating, shearing, ear tagging, or anything which results in a break in the skin so that the bacteria may gain entrance. The tetanus organism may gain entrance from the soil, manure, hands, or instruments. The first symptoms are usually noticed from three to seven or ten days after the infection occurs. The lambs or sheep become nervous, there is increasing stiffness throughout the body, and the head is drawn back. The legs become rigid and extended, and there is great pain during spasms, during which death occurs. Treatment is of little value, and affected lambs or sheep should be killed. No disease shows more clearly the need for great attention to sanitation and cleanliness about the quarters and in the performance of the usual operations.

Blackleg. Blackleg is more common in cattle than sheep, but all classes of sheep are susceptible. Where the organism gains entrance, often through a wound, the part is first hot and painful, but soon becomes cold and painless. There is gas formation under the skin. Sheep on areas where blackleg is known to have been found should be vaccinated. Treatment of affected sheep is of little use because of the rapid and fatal course of the disease. A malady that may be mistaken for blackleg is malignant edema, or gas gangrene, which gains entrance in the same way as the blackleg organism; it occurs where there is little regard for sanitary precautions when docking, castrating, shearing, or in cases of difficult lambing.

Stiff lambs. Stiff lambs or stiff lamb disease may be due to more than one cause. Arthritis (polyarthritis) affects the joints and may occur in lambs from a few weeks to several months of age. There is severe lameness, stiffness, lack of growth, and loss of condition. The trouble may last for many weeks. The organism is said to be almost identical with that causing erysipelas in swine. With very good care and nursing, the lambs may recover, but they may show effects for a long period.

Another type of stiff lamb disease is characterized by the white or cooked appearance of affected muscles, chiefly in the hind legs, although the front legs and shoulders may be involved. This diffi-

Courtesy Colorado A. and M. College

This sheep has a severe case of sore mouth.

culty attacks lambs when several weeks of age. Apparently it is not due to an infection, and hence is not contagious but seems to have some relation to the diet of the ewes and lambs. It seems to be most prevalent in the northeastern part of the country but occurs elsewhere also. Cornell workers report its occurrence may be associated with a lack of vitamin E, but this is not yet established as the definite or sole cause. In any case good rations are suggested, and there seems to be some reason to avoid the use of such feeds as cull beans. Lambs which have been growing well seem especially susceptible. When first noticed, lambs have difficulty in rising and walk with a stiff gait. Weakness becomes more pronounced, and if death does not follow the lambs are severely stunted.

Contagious ecthyma. Contagious ecthyma, pustular dermatitis, and other names are used in reference to a trouble which practical sheepmen know as soremouth, pox, doby mouth, et cetera. It may be observed in sheep of all ages, but is most prevalent in ewes and lambs and in feeder lambs shipped from one region to

another. It is characterized by the appearance of reddened, slightly swollen areas about the lips and nostrils or about the teats and udders. These areas increase in size, become filled with pus, rupture, and then are covered with a hard, dark-colored crust or scab. These persist for about three to four weeks when they drop off leaving no scar. In very serious cases the tongue and mouth parts may be involved. Death is not likely to result in a great percentage of cases, but there is much loss of condition because of failure of the lambs to nurse or eat. When the udder is affected, the ewe will not allow the lamb to suck, and garget may result. The trouble is due to a virus. The disease runs its course, and lambs that have been affected or vaccinated have a high degree of immunity. Treatment of the scabs is of little value, although antiseptic ointments and oils may reduce the soreness, but healing is not greatly hastened. Where there is much difficulty, lambs should be vaccinated.

Navel ill. Navel ill, or joint disease, is caused by bacterial infection of the navel of newborn lambs. Cases of navel ill occur where there is a lack of sanitation, as the bacteria are present in manure, dirty bedding, and filthy lots. The navels of all lambs should be treated with tincture of iodine or equally good antiseptic soon after birth. The entire navel cord should be immersed in the antiseptic by placing it in a wide-mouthed container and holding it snugly against the belly. But this must be accompanied with attention to general sanitation if trouble is to be avoided. Usually the lambs are about a week old before symptoms are apparent. In some cases death may occur in a few days; in others, the lambs may live for weeks but fail to thrive and grow normally. After the infection has occurred, treatment is not satisfactory.

Dysentery, or diarrhea. Dysentery, or diarrhea, is also an infectious disease of the newborn lambs that is associated with filthy surroundings. Lambs that are from one to two days of age are most often affected, although those up to three weeks may be affected. Death usually occurs in from a few hours to three or four days. Affected lambs have no desire to nurse, they show signs of distress and pain, the back is arched, and the belly tucked up. The feces may at first appear normal but later are grayish-white or yellowish with an occasional streak of blood. Because the disease runs such a rapid course, treatment is of no value in most cases. The source of infection is not the milk, but the teats and udder that have become contaminated with bacteria. Sanitary measures are

the only satisfactory means of control, and the caretaker must be very careful that he does not himself become the means of spreading the disease as he assists the ewes and their lambs. Unbedded, damp, poorly ventilated, poorly lighted, overcrowded quarters are fertile sources of the trouble. Until operators learn the full meaning and importance of sanitation in the bacteriological sense, lamb losses will continue from dysentery.

There have been many cases of severe outbreaks of dysentery in feeder lambs. These may be caused by organisms that are normal residents of the intestinal tract, at least in some sheep, and later develop into exceptional virulence when there are such predisposing causes as prolonged hunger and accompanying weakness. One type of the disease is called *paratyphoid dysentery;* it is characterized by dullness, refusal to eat, body temperature increase from 2 to 4 degrees, and profuse scouring, which may be bloody because of the inflamed condition of the intestinal tract. The only means of differentiating this type of dysentery from other diarrheas is by the isolation and identification of the organism. As with all other diseases, the well animals should be separated from the sick. The affected lambs should have intestinal antiseptics and a light diet. Prevention is accomplished to a very large extent by keeping the lambs in good condition through regular feeding, watering, and resting while they are en route from ranges to feed lots. It is such measures which help the animals to withstand the presence of the organisms and prevent their multiplication to a harmful extent. Some of the new sulfa drugs may be helpful in treatment, but prevention will be most satisfactory.

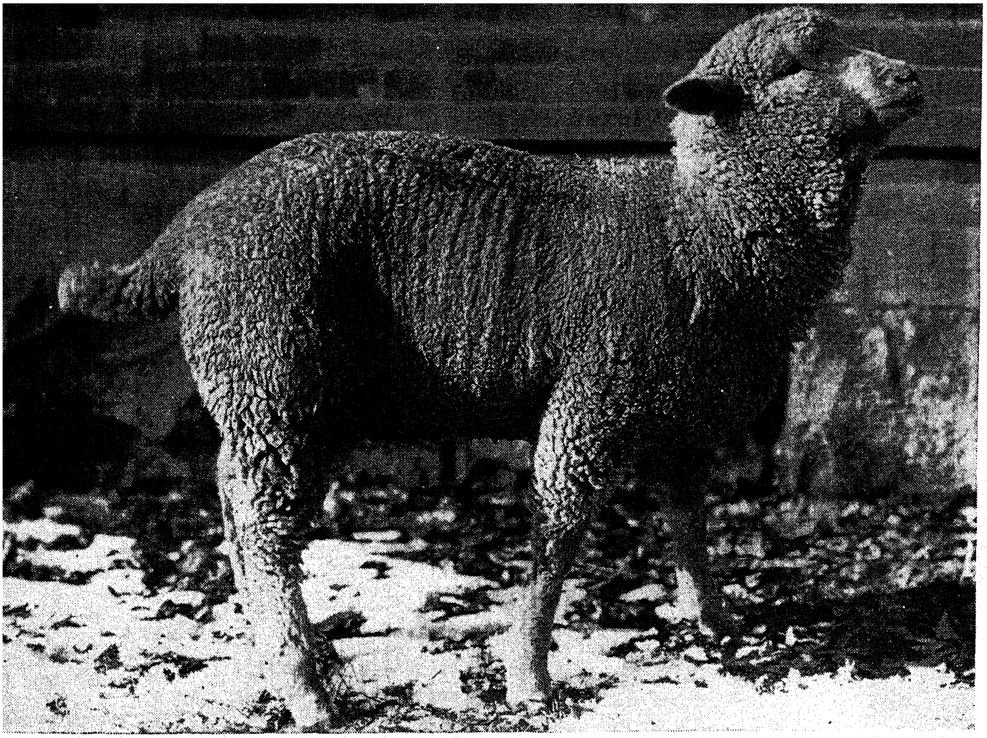
Coccidiosis. Coccidiosis, or coccicidial dysentery, is caused by a protozoan parasite. The disease seems to have become more frequent in recent years, and death losses may vary from 2 to 20 or 25 per cent of the flock. Laboratory technicians are able to demonstrate the organism in practically all lots of feeder lambs, and in many flocks of native sheep. Thus, it seems that when outbreaks occur, there have been events, such as extreme fatigue because of shipment, chilling, and lack of feed, that have depleted the strength of the lambs. Most outbreaks in feeder lambs occur in from one to two or three weeks after they arrive in the feed lots. The symptoms of coccidiosis are not greatly different from those of other dysenteries—bloody diarrhea, severe depression, loss of appetite, and consequent weakness. If the trouble cannot be checked in a short

time, death results. Recent developments in treatment relate to the use of sulphur and to some of the sulfa drugs as intestinal antiseptics. It has been reported that the disease has been successfully prevented through the addition of ground sulphur to the feed at the rate of 0.5 to 1.5 per cent of the ration. This would be from one-half to one and one-half pounds of sulphur to 100 pounds of feed. Sulfaguanadine and sulfamerazine have also been reported as valuable treatment materials. All sick lambs should be separated from the unaffected and given special care. While the organisms causing coccidiosis may live over on parts of the premises from one year to another, this is not a requisite for the occurrence of the disease, as the lambs bring the coccidia with them. In the case of farm flocks, changing to clean ground may be helpful.

Not all cases of scouring are due to the causes given, as there are numerous instances where the trouble is directly traceable to the kinds of feeds used or to the methods of feeding.

Overeating. Overeating, as a cause of death of lambs, has been experienced by every feeder of lambs. The trouble is associated with excessive consumption of grain and is called a great variety of names such as indigestion, apoplexy, food intoxication, gastroenteritis, and enterotoxemia. The primary cause is the consumption of too large amounts of grain or heavy concentrates. There is not unanimous agreement regarding the disease. Some believe that the trouble arises directly because the stomach is overloaded with too much weight in a concentrated form. Others think this is not in itself disastrous, that the real trouble is due to the toxins which develop as a result of the presence of certain organisms, notably one called Clostridium Welchii, which is a close relative of some other pathogenic organisms. That both of these may have some aspects of truth with respect to the trouble is possible. That there must be a certain "compactness" or lack of bulk in the ration to initiate the trouble is the observation of all feeders. A lamb eating two pounds of corn, as shelled corn, might have overeating disease; whereas, a lamb eating two pounds of corn, as ground corn, mixed with a pound or more of cut or ground roughage may show no effects from the heavy-grain ration. It is the author's belief that lambs do not suffer from overeating when there is the proper physical balance of the ration, even though the chemical balance may not be of the best.

Lambs that suffer from overeating are invariably the biggest,



Courtesy Colorado A. and M. College

This is a typical pose of a lamb suffering from overeating.

most vigorous, fastest gaining, and best feeders of the lot. The affected lambs may stand with their heads drawn upward or thrown back, suddenly stagger, fall to the ground, and die in a few minutes in convulsions. Others may live for a few hours, some may live for several days. Some may vomit grain, develop diarrhea, and later die, or they may resume eating after a few days and gradually recover, although they may lose part or all of the fleece as a result of the illness.

Founder. Founder is a result of overeating or overdrinking. It is characterized by lameness, often followed by a deformity of the feet. On post mortem examination the paunch is heavily loaded with grain and little or no roughage. The small intestines may be well emptied and may or may not show an inflammation, depending upon how long after the onset the lambs live. Treatment seems to be a waste of time. Complete prevention is not possible with the usual hand-feeding of grain and roughage. If the amount of grain is greatly reduced, fattening is too slow. An abundance of palatable roughage is an important aid in prevention. Grinding the grain

and roughage and mixing to increase the bulkiness of the ration is probably the most reliable method of control. In field feeding, such as lambing down corn, the use of additional roughage is about all that can be done. Despite all that has been written to the contrary, there are feeders who successfully fatten lambs in cornfields and others who self-feed lambs on shelled corn and hay in separate feeders. The latter practice is considered too hazardous to recommend widely. If followed, self-feeding should be started as soon as the lambs are put on grain feed.

Bloat. Bloat is an excessive accumulation of gases in the paunch, which is associated with certain types of vegetation or feeding, although there seems, too, to be a predisposition to bloat in some animals. Certain individuals bloat to some extent on almost any kind of feed. Bloating is characterized by great distention of the upper left side of the abdomen. This distention in severe cases extends to the right side also, there is great pressure on the diaphragm with consequent inability to breathe, and the sheep dies of suffocation. Earlier, the animal stands with the nose held forward, the legs are spread, breathing is rapid, and there is evident distress.

Nursing lambs seldom bloat seriously. Most cases of bloat occur on lush pastures, such as young clovers or alfalfa, although there are many cases in dry lot as well. It has long been thought that the lush-growing plants produced more gases because they were more readily fermented than more mature plants. Recent work, especially at the California Station, has shown that this is not the case; and while belching and the escape of gas is less likely to occur on such feeds, the gas formation is no greater. The stemmier, more fibrous nature of more mature plants stimulates belching, due to certain mechanical features and less likelihood of the feed being consumed in such great quantities as to interfere with the escape of gas through the cardiac opening into the stomach. Thus, there is a sound basis for the recommendation for the use of some dry roughage along with such pastures. It is also advisable to have mixed pastures or to let the clovers and alfalfas attain some degree of maturity. Moist pastures are not particularly more dangerous than dry pastures.

Treatment of bloated sheep consists of measures that will stop the formation of additional gas and will assist in the removal of that already present. Fastening a stick in the mouth and standing

the animal with its front feet higher than its back feet may help. Chewing on the stick may cause belching. If the sheep is not severely bloated but treatment is thought advisable, not to exceed a tablespoonful of formalin or of bicarbonate of soda in half a pint of warm water may be given. From a pint to a quart of warm milk is sometimes given. In more severe cases such methods will not suffice. It may be necessary to tap the abdomen and paunch with a small knife, or a trocar, and to insert a canula through the left flank midway between the posterior rib and the hip bone. Many cases of severe bloat have been relieved by forcing a piece of hose down the gullet and into the paunch. The front feet should be elevated. A piece of hose one-half to three-fourths inch in diameter and about two or two and one-half feet long is used. Relief will be immediate. If the stomach contents plug the hose, the operation may need to be repeated or a smaller article passed carefully down inside the hose to provide an opening.

"Bighead." Bighead is due to dropsical or edematous swellings of the ears, eyelids, lips, and lower jaw; finally, the entire head and tongue may be involved. Eating and drinking may be impossible because of the swellings. The sheep rub the affected parts as though there was intense itching. There is frequently a nasal discharge, and there is a rise in temperature to 105 degrees or higher. The trouble may develop very rapidly, as the head may become so swollen in from thirty minutes to an hour's time that the animal cannot see. Death may result in a few hours in extreme cases, or it may require several days. In milder cases there is complete recovery. The trouble seems to be widespread in certain seasons in both the range and farm states. Climatic conditions and the consumption of certain plants that cause the animal to become sensitized to light seem to be the main causes. Affected animals should be placed in shade or a darkened pen as soon as possible after symptoms appear, and all swollen parts should be thoroughly rubbed with olive oil. Poultices of one pound of Epsom salts to a gallon of water have also been recommended.

Listerellosis. Listerellosis, or circling disease, is of comparatively recent occurrence in this country, or it has been confused with other troubles earlier. It is an infectious disease of the central nervous system with the focus of infection in the base of the brain. It does not seem to be highly contagious, and the manner in which the organism gains entrance is not understood. The affected ani-

mals die in from two to five days. The disease symptoms are chiefly walking or running in a circle, blindness, standing with the head against some object, and later, coma and death. Gross post-mortem examination shows no lesions, but laboratory examination reveals destruction of some parts of the brain tissues. Care should be exercised in handling sheep that show any such symptoms, as the disease has been found in other animals and man. There is no satisfactory treatment. Vaccination of large numbers of animals has not been of value. Most cases have been observed during the winter months.

Urinary calculi. Urinary calculi, gravel, or stones are collections of minerals which develop in the kidneys or bladder and become lodged in the urinary tract of rams and wethers. They interfere with the passage of urine, and in cases where there is complete stoppage, death results unless the calculi are successfully removed. The stoppage generally occurs at the extreme end of the penis or at the S-shaped turn in the urethra. From the latter region an operation is necessary to remove the gravel, although in some cases they may be easily removed from the other location by means of a very small piece of wood or metal instrument. Beets and mangels were formerly held responsible for the trouble, but work at some of the experiment stations has not supported this view. A lack of vitamin A has also been ascribed as the cause, but this does not explain those cases that occur on green pastures. This lack may contribute to the difficulty, but it also seems likely that rations that have high mineral content combined with a lack of an abundance of water, so that a concentrated urine results, may have some relation to the incidence of the trouble.

Uneasiness is one of the first symptoms noticed. The sheep stand still and strain to urinate. Later, there is swelling of the abdomen, the bladder may rupture, and death follows. There may be small granules about the sheath. The administration of medicines is of no value. If the trouble occurs in feeding lambs in any significant numbers and the lambs are nearly ready for market, it is wise to ship the entire lot. In all cases sheep should have an abundance of water and a ration well balanced with respect to nutrients, including vitamin A.

Pneumonia. Pneumonia is an inflammation of the lungs and may be the result of several different causes. Some cases may be due to weakness brought about by an infestation of lungworms. Chilling and the loss of resistance to bacteria result in many cases

of the disease in both lambs and older sheep. Overheated show sheep often die as a result of pneumonia. Carelessness in the administration of drenches and other medicinal treatments may introduce foreign materials into the lungs and result in the disease. This latter type is often called "mechanical pneumonia." Coughing after treatment may be the first warning. There is no highly satisfactory treatment for lungworms in the first instance, and treatment for pneumonia seldom results in complete recovery, no matter what the cause of the disease. All cases are characterized by difficult breathing and a rise in temperature. Congestion of the lungs progresses rapidly, and death follows in a few days. In cases that do not cause death, recovery is seldom complete; the unthriftiness, lack of vitality, and difficult breathing result in the condition herders describe by the term "lunger." In endeavoring to treat affected sheep, it is important that they have dry, reasonably warm quarters with an abundance of fresh air. They need fresh water and very palatable nutritious feeds. Some of the newer drugs may be of value in some cases, but these should be given by veterinarians.

Hemorrhagic septicemia. Hemorrhagic septicemia is a term applied to several conditions frequently called shipping fever or stockyard fever or exposure disease. The trouble is seldom seen unless there has been some condition which has resulted in a lowering of the resistance of the animal and permitted pathologic organisms to multiply within the body. Some organisms found in the organs of affected sheep are also inhabitants of healthy animals. Thus, it is likely that some predisposing factor such as extreme fatigue due to a long shipment, sudden change in feed, or bad weather precedes the development of the trouble. There is a rise in body temperature of several degrees, labored respiration, and loss of appetite; often coughing and a discharge may be noticed from the nostrils, along with "weepy" eyes.

In the case of feeder lambs the trouble usually appears within the first two weeks after they arrive in the feed lots. Affected lambs may die within twenty-four hours; indeed, some die without the caretaker having noticed the presence of the disease. Some veterinarians report that the trouble is self-limiting; that is, it is not directly contagious, and good care is all that is needed to check the spread of the trouble. They think there is no merit in the use of such products as hemorrhagic septicemia bacterin or aggressin.

Others think vaccination is helpful in certain outbreaks although ineffective in others. In any case it seems likely that vaccination would be most helpful if performed before the disease appears in the flock.

Nasal catarrh. Nasal catarrh, rhinitis, snuffles, colds, and "snotty nose" are terms applied to sheep that have a thick mucus discharge from the nostrils. The condition may develop as a result of the presence of grub in the head, but it is also due to wet weather, chilling, close confinement, dust, changes in the weather, and perhaps other factors. There is undoubtedly greater resistance to the condition in some individuals and in some breeds than in others. Few sheep die as a result of this trouble alone, but is not a pleasing condition in the flock, and management should be such as to keep it at a minimum. Very susceptible sheep should be culled. Treatment is of little use. Recovery is usually complete, although in some cases considerable time is required.

Ketosis. Ketosis, or pregnancy disease, or lambing paralysis, is also known by several other names. It is commonly seen in ewes that are within about two weeks of lambing. Most of the ewes that are affected are carrying twins or triplets and are receiving dry feed and restricted exercise. There are few cases on good pastures. The disease is apparently due to improper and inadequate nutrition. Specifically, it is related to the metabolism of carbohydrates late in pregnancy. It may occur in fat or thin ewes. Good management and a good supply of easily assimilated carbohydrates in the diet are essential in prevention. During late pregnancy the fetuses develop very fast and occupy a large amount of the abdominal space. The ewe has difficulty in eating enough feed to supply her own needs and those of the unborn lambs. Bulky rations of low quality feeds do not supply enough carbohydrates. Hence, because of the reduced capacity of the ewe for feed, grain should be fed during the last month of pregnancy. Since there is a great demand for sugars and energy, a good part of the ration should be of corn or a similar feed. This was discussed in the chapter on feeding ewes. There will be few cases in well-managed and well-fed flocks. This is one of the difficulties that is closely related to good feeding based on principles of nutrition.

In the early stages of the disease the ewes are less active than the rest of the flock and walk very slowly. Later, they become weaker, show stiffness of gait, difficulty in rising, may walk in a

circle, and stand with the head against an object. As the disease progresses, the ewe cannot rise and lies with the head turned around to the side. Other symptoms are rapid breathing, blindness, and grinding of the teeth. Treatment, if given promptly, is helpful. The ewe should be given at least a half cupful of sugar or molasses three or four times daily. Each dose of the sugar or molasses should be given with about a quart of water. The ewe should be offered choice feeds. After the lambs are born the ewe will make a complete recovery. Exercise is important for unaffected ewes, but those with the disease should not be disturbed except to help them rise and stand and change their positions in the pen. Post-mortem findings include a very friable yellow-colored liver as the most evident change visible by gross examination.

Abortion. Abortion is much less common in sheep than in some other animals. Few cases of abortion are due to an infective agent, and very few of those are due to the Bang's organism. Some are due to an organism known as a vibrio. Contaminated water seems to be a common source of infection with this as well as some other germs which might cause abortions, hence the relationship of sanitation to the prevention of abortions. Most aborted fetuses are dead or die very soon after being expelled. Besides these causes of abortion, some cases are due to serious deficiencies in the ration, and others are due to injuries. It is a good plan to mark any ewes that abort and remove them from the breeding flock.

Eversion. Eversion or prolapse of the vagina and uterus may occur before or after lambing. This condition is often spoken of as protrusion or throwing out of the womb. The exact cause is probably unknown, but it seems to have some relation to urination, and some believe it is associated with the accumulation of large amounts of urine in the bladder with a tendency to force the womb over the bladder. Then constant straining weakens the tissues and forces the uterus outward. There is also the likelihood that there may be some heredity weakness that predisposes to the trouble. All affected ewes and descendants should be culled. The condition may also follow difficult lambing. It is readily noticed and is a repulsive sight, and if not corrected death may follow in a few days. Treatment consists of carefully washing the parts with a warm, mild antiseptic solution such as two per cent carbolic acid, applying a light mineral oil or carbolized vaseline, and replacing the organs. Elevation of the hindparts of the ewe may be necessary. Sutures or

some other device may then be used to hold the organs in place. In the author's opinion a very smooth, properly shaped piece of wood about eight inches long and one inch in diameter inserted into the vagina and held there by strings tied around the protruding end and fastened to bits of wool at the sides of the dock is one of the most effective devices for the caretaker to use. This does not interfere with urination and can be removed at lambing, or if the trouble occurs after lambing, usually not more than a week is required to result in correction. The piece should be removed and washed if a longer time is required.

Mastitis. Mastitis, or garget, or swollen udders, sometimes give considerable trouble. Several kinds of bacteria may be involved, or a single kind may be present. The infection seems to enter through the teats or through slight wounds on the udder. Some cases develop very fast and cause a condition called "bluebag," which often results in death of the ewes. The other milder type may cause abscesses and spoiled udders. Many cases occur soon after lambing, although the difficulty is not restricted to that season. The udder is sore and swollen, the milk is not fit for the lamb, the ewe will not let lambs nurse, and she stands with legs apart, is feverish, and does not eat or drink. The milk may be lumpy, watery, and yellowish, or it may be streaked with blood, be very thick, and have a foul odor. Lambs should be removed and fed on other ewes or raised on cow's milk. The use of ointments and hot compresses or other types of heat on the udder may be helpful. Sulfa drugs are helpful in some cases, but should be given on the advice of a veterinarian. The percentage of complete recovery is very low. All affected ewes should be immediately separated from the rest of the flock as a precautionary measure. The trouble can be prevented better than it can be cured. As in so many other cases, sanitation is of utmost importance. The removal from the pens or corrals of all objects that might injure the udder is also mandatory. The examination of the udders of all ewes before lambing is a useful procedure. All ewes that have had mastitis should be culled and not used for further breeding.

In addition to the foregoing diseases and difficulties, there are others that are the result of the presence of parasites. From the viewpoint of sheep husbandry, these parasites may be classed as external and internal; but from the standpoint of the parasitologist, the classification is by no means so simple. No attempt is made here

to include the detailed descriptions of the various species, but it is the aim to include enough to give the student a reasonable basis for appraising the far-reaching depredations and the economic importance of parasitism in sheep. Despite the importance of the diseases already mentioned, it is probable that parasitism may provide the weakened condition and lowered vitality necessary for bacterial diseases to become established. The flockmaster must be alert for evidence of parasitism and aware of the most effective features of management and simple medication for control. As with other difficulties, prevention is far more satisfactory than treatment after severe parasitism has developed. Much of the economic loss caused by parasitism is not due to the death of sheep and lambs, although that is by no means small. Greater loss is occasioned by the setbacks to growth and development that result from parasitic infestations.

External parasites. External parasites are generally less destructive than internal parasites, but the damage they do may be great, as they cause severe irritation, restlessness, rubbing, loss of wool, and an unthrifty condition. Moreover, the presence of external parasites in one flock in a community is a constant threat to others when there is an exchange or purchase of breeding stock.

The common scab mite and other mites. The common scab mite (Psoroptes ovis) is one of the most destructive of the external parasites and also one of the most difficult to control. Three other mites occur much less frequently but are sometimes very troublesome. The sarcoptic mites burrow into the skin where there is little wool and form deep crusts. They are most common on the head and face. On the hairy parts of the legs often just above the feet are found the chorioptic mites. They live on the surface of the skin, causing much irritation and itching. A fourth type of mite is called demodectic. These live in the hair follicles and skin glands and produce small pimples.

While all of these mites are very contagious and easily spread, the common scab mite is probably most feared in this respect. Scabies, or sheep scab, caused by this mite, has been known for centuries and is distributed over much of the world. The mites are oval shaped and of a yellowish-white color. They are generally said to be microscopic and hence invisible to the naked eye, but they may be seen without being magnified if a black background and good light are provided. Males are about 0.5 mm and females

0.65 mm in length. The mites normally spend their entire life on the host. The eggs laid by the females hatch in about three to seven days if next to the skin where conditions are most favorable. Various stages are passed through, and a complete cycle of egg to egg may require only twelve to fifteen days. Although it was formerly believed that the mites could live for a year or more off the host, this has been disproved, and few survive for as long as thirty days even under favorable conditions. Most perish within fifteen days in sheds and corrals.

Symptoms of infestation usually appear about a month after exposure. The mites may inhabit most parts of the body, although they are most common on such parts as the shoulders, sides, back, and hips. Scab may be suspected when the sheep are seen rubbing and biting these parts. The mites feed upon the skin and suck out fluid. The wounds are inflamed, and serum is exuded and dries and forms a crust or scab. The edges of these scabs are red, moist, and shiny, and it is at these points where most of the mites are found. The inflamed areas enlarge and spread over the entire body. The biting and scratching and inflammation cause the wool to loosen and drop off, and the sheep presents a sad appearance. The presence of the mites is usually readily demonstrated by some skin scrapings from near the sores. When carefully examined, especially with some magnification, the mites may be seen moving about. The disease spreads through the flock by direct contact of the infected animal with others. The disease is less noticeable in summer than when the sheep are closely confined in winter.

There is only one satisfactory method of handling scabies. The entire flock must be dipped in preparations that will destroy the mites. Only two dips are recognized by the Bureau of Animal Industry of the United States Department of Agriculture as effective against scabies. These are lime-sulphur, testing not less than 2.0 per cent "sulfidesulphur," and nicotine sulphate, testing not less than 0.05 per cent nicotine. There is no other effective means of curing the trouble, although during cold weather when dipping is not feasible, sponging the affected parts with the dipping solution will lessen the spread and give some measure of control. It is not possible to give medicines in the feed or as a drench to destroy external parasites. Two dippings are necessary and should be made under the direction of the Livestock Sanitary Officials, to whom all suspected cases of scab should be reported. Ten to twelve days

after the first dipping, a second is necessary to kill the mites that hatched after the first dipping and before they are old enough to lay eggs. It is important that the hard scabs be broken by vigorous rubbing and the dip be used at temperatures of 103 to 110 degrees F. The sheep should remain in the dip for two or three minutes, and all parts of the body, including the head, should be thoroughly wet. After dipping, the sheep should be placed on a clean pasture or in a clean corral where scabby sheep have not been for some time. By these methods scab has been eradicated in many areas of the United States. Willing compliance with sanitary regulations will result in its complete eradication throughout the entire country.

Ticks. Ticks are widely distributed and are one of the most common parasites of sheep. The sheep tick (Melophagus ovinus) is also called ked. Oddly, the sheep tick is not a member of the tick family as described by entomologists, but is a wingless, parasitic fly. The entire life of the tick is spent on the sheep. Although ticks are more common on the medium- and coarse-wooled breeds, the fine-wooled breeds are by no means immune. Sheep ticks are brown and have six legs. The adult female is about one-quarter inch in length, slightly larger than the male. They are easily seen when the fleece is parted. When feeding, they are firmly attached to the skin, which they have punctured in order to suck blood and lymph. They cause much irritation and restlessness, rubbing and loss of wool. They may be controlled by dipping.

Ticks do not lay eggs. The egg is retained in the body of the female until it has developed into a larval form, which occurs in about seven days. This larva is deposited in the fleece and is attached to the wool fibers by a glue-like substance. When first deposited, the larva is covered with a white, soft membrane which soon turns brown and hard. The pupal stage is passed in this puparium or shell. The pupa emerges from the shell in 19 to 24 or more days, depending upon the temperature of the weather. The young tick grows rapidly after its emergence and reaches sexual maturity in three or four days. Within eight or ten days after mating, the female may deposit the first pupa, followed by others at about weekly intervals until 12 or 15 have been deposited by each female.

Adult ticks cannot live more than four or five days off the host, but the pupa may survive for a longer time, especially in warm

weather. Thus, it may take some time to rid the premises of all danger of reinfestation after dipping. With the most effective modern dips, enough dip is retained in the fleece to destroy some of these survivors when they get onto recently dipped animals. Ticks are very troublesome in cold weather, and the flock should be freed of them before cold weather when dipping is not feasible. Shearing removes many of the ticks and larvae but is not a method of treatment. Unless dips are used that remain in the fleece for a long enough period to kill the ticks that emerge from the pupal stage, a second dipping is necessary in three to four weeks.

Lice. Lice of two kinds infest sheep. Sucking lice, which obtain their food by puncturing the skin and sucking blood, are the most common. There are two species of these, which are designated technically as Haematopinus ovillus and Linognathus pedalis. The former are found on the body, especially about the shoulders and along the back, and the latter chiefly about the feet and legs below the knees and hocks. The other kind of lice that infest sheep are biting lice, Trichodectes sphaerocephalus. These live on surface materials on the skin. They are common in the western range sections but are also found in other areas. It is generally not necessary for the sheep raiser to be able to distinguish between them, although there are distinct features by which this may be done. Sucking lice are distinguished by being larger and by having pointed heads that are longer than broad, while the opposite is true of the biting louse.

Both kinds of lice lay eggs or nits on the fleece close to the skin. Hatching occurs in 10 to 18 days. Lice do not live more than a few days to a week if they are off the host. The damage to sheep is largely due to the irritation of the skin and consequent rubbing off of wool and to the lack of thrift caused by restlessness. Light infestations are not especially harmful, but the increase and spread are rapid, particularly in cold weather. Lice can be seen with the unaided eye, but the search must be thorough, for they are similar in color to the color of the skin and if not moving appear like some grass seeds on the skin.

The only satisfactory method of treatment is by dipping. Since dips will not destroy the unhatched lice, dipping must be repeated in from 14 to 18 days unless a dip is used that leaves effective residues in the fleece for that period of time. Dusting and spraying are usually not satisfactory unless the sheep have short

fleeces. Dips or dusts containing some forms of sulphur, Rotenone, or DDT are effective in killing ticks and lice.

Dipping. Dipping sheep for the control of external parasites is an important phase of management. It is the most satisfactory means of control of such parasites. In dipping sheep and lambs, attention should be given to numerous details. Regardless of the number in a flock that are infested, the entire flock should be dipped. The most economical time to dip is about two weeks after shearing, for at that time the shorn sheep remove very little dip from the vat in their fleeces. Dipping does not improve wool directly, and any effect upon the fleece is due to the better thrift of the flock because of freedom from external parasites. Shear cuts should be well healed, especially when lime-sulphur or arsenical dip is used, in order to avoid poisoning the animals through cuts in the skin.

The sheep should be handled quietly, and the lambs should be dipped separately from the older sheep. The sheep should not be heavily fed just before dipping. The work should be done on a warm, sunny day. The vat should be large enough and contain sufficient solution to allow the animals to be completely submerged. The head should be ducked under only momentarily. The temperature of the solution should be from 95 to about 105 or 110 degrees F. The sheep should remain in the vat for not less than two minutes. When the solution becomes very dirty, a new mixture should be prepared. Spraying equipment is sometimes used to apply the solution rather than immersing the animals in the vat of the material. The vat should have a drain and an incline for the sheep to walk out; there should be a draining platform to catch excess dip that runs off them and carry it back into the vat. Portable dipping vats have been used in many states for dipping small flocks, but the well-equipped sheep farm or ranch should not be without dipping or spraying facilities.

Internal parasites. Internal parasites are among the most troublesome of all conditions that affect farm flocks. Serious losses are experienced in other regions also, if not in death of the lambs and sheep, in the setbacks to development that internal parasites cause. While such losses are not sensational and are difficult to evaluate, the annual toll is very high. There are many different species of internal parasites, but relatively few are the cause of important losses. The losses due to parasitism are stressed because

of the absence among sheep of such widespread death-dealing plagues as tuberculosis and cholera that have taken such heavy toll among cattle and hogs. Until recently, there were no thoroughly effective treatments for control, and because many parasites are visible to the unaided eye, in contrast to the lack of such visibility of bacteria, losses have been ascribed to that which is most readily seen. This is not meant to minimize parasitism but merely to point out that losses may be due to other causes, even though parasites may be present at post-mortem examinations.

The practical sheepman knows some of the more common parasites by common names. A scientific nomenclature is also used for more precise identification, along with detailed descriptions of the parts of each parasite. There are both harmful and apparently harmless parasites, in addition to those discussed here, that infest sheep.

The presence of internal parasites is indicated by certain symptoms, but these symptoms are by no means truly diagnostic, for any of the cardinal symptoms of parasitism may be duplicated by many extraneous causes. The presence of the parasites or of their eggs or larvae in the feces is necessary for a confirming diagnosis, as the usual accompaniments of parasitism such as emaciation, anemia, edematous swellings (such as bottle jaw), diarrhea, depraved appetite, or general unthriftiness are merely indicative of parasitism, and all may exist without this condition. Parasitism is most common where climatic conditions are most favorable for the development of those stages which the parasites must spend outside the host, and where there are relatively large numbers of sheep that are confined rather continuously to a small area. These conditions are not so frequently found in the range areas, and hence parasitism is most important in the farming areas, although, by no means, are all parts of the range areas free. Certain parasites are abundant in some range sections but absent in other areas.

Although it is possible for the producer to undertake post-mortem examination, this is inadvisable unless he has had considerable experience, and the flock should be of such size as to justify engaging a veterinarian or the facilities of a diagnostic laboratory. Diagnosis must be followed by proper treatment. Even this is of little avail if preventive features are not incorporated in the flock management. These features are based on a knowledge of the life cycles of the parasites.

Roundworms. Most of the roundworms do not require an intermediate host for the completion of the life cycle, but tapeworms and flukes must pass through such hosts before the parasites can complete their life cycles and again infest sheep.

In practically all cases, the eggs of the roundworms pass from the infested animals in the feces. The eggs develop into infective larvae on the pastures in a few days to a few weeks, depending upon temperature and moisture. The eggs do not hatch below 40 degrees F., and below-freezing temperatures destroy many if not all of them. Dryness also destroys them. The newly hatched larvae are readily destroyed by freezing and drying. The eggs must hatch and the larvae develop to certain stages before they are infective to sheep. If eggs or preinfective stages of the larvae are eaten, they do not complete development inside the sheep.

After the larvae have reached the infective stage, they are able to survive unfavorable conditions for some time. They migrate short distances when the vegetation is wet and attach themselves to stalks of grass. In this stage they are ingested by grazing sheep and complete their development in that part of the host which they inhabit as adults. The time that adult parasites may exist in the host has not been determined for most of the species and the exact time for none. But this is a long period, and it is the adult parasites that provide the chief, if not the only, source of infestation after prolonged periods that are unfavorable to the existence of the parasitic larvae. The removal of adult parasites can only be accomplished by medication. Good feeding and management are important in enabling animals to resist the effects of parasitic invasions. Lambs are usually much more susceptible than mature sheep, but losses in adult animals are not uncommon.

The stomach worm. The common, eastern, or twisted stomach worm, Haemonchus contortus, is one of the most serious of the roundworms infesting sheep. It was probably introduced into the United States many years ago, and because of favorable conditions in many localities and the transfer of infested animals from one region to another, severe losses have occurred during the last fifty years. Few flocks, especially in the central, southern, and eastern areas are now free of this parasite. In many range flocks the infestation, if present, is so slight as to pass unnoticed. The toll is exacted not only in deaths but in the great setback that the whole flock suffers. The appearance of infested lambs on the markets calls

forth one of the worst criticisms of market men. To have it said of a lot of lambs "they are a wormy lot" is equivalent to saying the flock from which they came is an unprofitable one.

The life history of the stomach worm has been extensively studied, and many essential facts relating to its control have thereby become known. The adults live in the abomasum or fourth section of the stomach, although a few may also be found in the anterior portion of the small intestine. The females are slightly larger than the males—about one or one and one-half inches long and three-quarters to one inch long, respectively. Mating occurs in the abomasum, and the females lay enormous numbers of eggs, microscopic in size, that pass from the sheep in the feces. Many of the eggs are segmenting when passed. When conditions are favorable, the eggs may hatch or complete embryonating in a few hours, and the infective stage may be reached in as few as 72 hours after passing from the host. In most cases conditions are not favorable, and the development may require from a week to several weeks. Warmth and moisture hasten the development, while severe dryness or freezing may retard it or, if prolonged, may even destroy the eggs or the developing larvae. According to the United States Department of Agriculture, eggs do not hatch below 65 degrees F. As the development continues, the larvae molt but retain the cast skins as protection and, thus, in the infective stage are enclosed in a thin coat or sheath. This is the final stage to which the parasites develop outside the sheep. In this condition they are able to exist for a considerable period, but apparently not so long as previously assumed, as recent work has shown that most perish within two months, and few survive for as long as four months. The survival period is influenced by external conditions.

The larvae are capable of moving about when the vegetation is moist. They react to light and move to avoid direct sunlight. They attach themselves to vegetation and are taken into the bodies of grazing animals along with the forage. This explains why lambs that are raised in dry lot do not usually become infested to a harmful extent, even though the older sheep may be infested. When the larvae have entered the stomach of the sheep, development is resumed, and upon becoming adults, the above cycle is again initiated. The exact length of time that the adults may live in the host is not known, but it is undoubtedly a period of some months; in many sections where sheep are not kept on pastures during the

winter, it is likely that the chief source of infestation from year to year is from the adult parasites that live within the hosts during this time. Since adult worms do not develop without going through this cycle, all parasites found in an animal have been taken in with the feed or perhaps in water, especially if it is run off from infested areas.

Stomach worms may harm sheep in several ways, but it seems likely that the main damage results from the blood drawn from the mucous lining of the stomach. There is considerable irritation of the mucous membranes during this process. The result of this withdrawal of blood is consistently observed in heavily infested animals. The skin is pale or whitish in color instead of the usual healthy pink. The eyeballs and the inner sides of the eyelids are white, and the veins are bloodless. Infested animals may eat dirt, and swellings may appear under the jaw. The wool is dry and lusterless. Thinness and weakness accompany the other symptoms. There may also be severe diarrhea, but this may not always be noticed, especially in older sheep. Lambs become so weak that they die, and older sheep may die suddenly, particularly during hot weather or if subjected to much exertion.

No symptom or group of symptoms is, however, a positive clue to the difficulty, as identical symptoms may be exhibited in other cases of infestation by some other parasites; it is only by post-mortem examination of the intestinal tract or by microscopic examination of the feces and identification of the eggs that one may be sure a correct diagnosis has been made. A post-mortem examination should be made soon after the animal dies, or the worms may be disintegrated and hard to find. Since some diseases of animals are communicable to man, one should be very careful to avoid all unnecessary risks; rubber gloves should be worn and the hands thoroughly washed with a suitable antiseptic and cleanser after doing such work.

In making the post-mortem examination, after the abdomen is opened, the abomasum of the stomach is readily located, as it is the enlarged portion to which the small intestine is attached. A slit is made in this, and as it is held open the worms may be seen moving about if the body is still warm. In case of a very heavy infestation there may be thousands of the worms, but it is usually possible to find the parasites if one looks thoroughly, even though there are only very few. When few are present it is likely that there

are other reasons for some of the symptoms, and, in such cases, the examination should continue until all parts of the alimentary tract, as well as the major organs, have been studied. But most diagnoses will then need to be referred to a veterinarian.

Not all sheep are equally susceptible to stomach worms, but a heavy infestation in one animal is indicative that all others that have been on the same pasture are very likely infested or will soon become so if continued on that area.

Medicinal treatment is the only way to remove the worms from the sheep, but no treatment is completely effective in all cases. Some treatments that were formerly widely used have been superseded by safer and more effective remedies. Those which are now extensively used are copper sulfate or bluestone, copper sulfate and nicotine sulfate (cunic mixture), tetrachlorethylene, and phenothiazine. Up to the present, investigators have reported little success from remedies, such as tobacco dust, that are mixed with the feed, salt, or drinking water. Although certain drugs, such as phenothiazine, administered in this way may have desirable effects, critical tests have failed to justify the use of others, and reliance should be placed on specific treatments that are given in proper dosage and under conditions that enhance their effectiveness.

Copper sulfate is used as a drench in a one per cent solution, although some advise a one and three-quarters per cent solution. An approximate one per cent solution may be made by dissolving one pound of copper sulfate in 9½ gallons of water. It is generally recommended that only the clear blue crystals be used, but chemists report that the copper sulfate that has become powdered is the same as the clear crystals become when they are dissolved. The material is easier to dissolve if some very hot water is used, and the extra water needed is then added by using water at usual temperatures. A concentrated stock solution may be made or purchased, kept for a long period, and diluted to the proper strength before using.

Because of the corrosive action of copper sulfate on metal, only glass, enamel, or earthenware containers should be used. This is a precaution which must not be overlooked if disastrous results are to be avoided.

The dose varies with the size and strength of the animals. Usually one ounce is given to lambs weighing about 50 pounds, two ounces to those weighing 75 to 100 pounds, and three to four

ounces to older and larger sheep. Very large animals may be given larger doses—up to six ounces. If the sheep are on permanent pastures, the treatment should be repeated every three to four weeks. The use of copper sulfate in salt is not effective in destroying the parasites and may lead to copper poisoning, as the copper seems to accumulate in the body when administered in this way.

The administration of this or any other drench is an important matter, as it may result in the death of the animal if any enters the lungs. Feed and water should be withheld for twelve to eighteen hours before and two to three hours after treatment. Animals should not, however, be treated after prolonged fast without first having some feed. In drenching, the animals should be standing and the head should be raised just enough to permit dosing. The dose should be given slowly to permit normal swallowing. Various items of equipment may be used to drench, but one of the best is a rubber bulb syringe with a hard rubber tube about 8 inches long. These may be obtained in various sizes, and the dose is measured as the syringe is filled; a bottle of suitable size with a piece of rubber tubing and funnel, a plunger type syringe, or drenching horn may be used. In treating flocks of several hundred, a lot of 25 to 50 should be closely penned and treated rather than trying to treat the whole lot as a unit.

A more effective treatment than copper sulfate is a mixture of copper sulfate and nicotine sulfate. This is more destructive of immature stomach worms and other species of roundworms, as well as tapeworms, than copper sulfate alone. This is usually made by using the one per cent copper sulfate solution as given above and adding one ounce of Black Leaf 40 (nicotine sulfate) to each gallon of the solution. The dosage is the same as given for copper sulfate alone. The same precautions should be observed. This is a more drastic treatment than copper sulfate alone, and if given in too large doses, fatalities will result.

Tetrachlorethylene is a liquid that has been extensively used in the past few years as an anthelmintic. It is administered in soft gelatin capsules which are sold under various trade names. These are prepared in two sizes containing approximately 2½ and 5 cubic centimeters of the material and used for lambs and sheep respectively. This substance is destructive of various types of stomach worms and of some of the parasites in the intestinal tract. In single doses it is not capable of destroying all of the parasites in

every sheep to which it is given. Sheep seem to tolerate the drug, and there is not great danger in giving it, but care should be taken so that the capsules are not broken in the mouth. The capsules are best given by the use of capsule forceps. Tetrachlorethylene treatment is more expensive than copper sulfate but has the advantage of greater effectiveness against some other roundworms. It is now being superseded by phenothiazine.

Phenothiazine is the most effective of the anthelmintics used for the destruction of internal parasites of sheep. While not effective against all parasites, it does remove more different species than other treatments. It is not effective against tapeworms, whip worms, and some others. It is more expensive than copper sulfate alone or with Black Leaf 40, but it is safe and does not require the withholding of feeds before it is given. It may stain the wool if urine of recently treated sheep gets onto the fleeces because it oxidizes when eliminated from the animal and forms a reddish stain.

Phenothiazine does not mix with water, and drenches must be prepared with some wetting agent added. A drench of phenothiazine may be administered by the "quick method," which is not suitable to use with copper sulfate as the latter, to be effective, must pass directly to the abomasum. In using the "quick method" a plunger-type syringe fitted with a nozzle six inches long and about one-quarter-inch diameter is best. The nozzle is inserted into the sheep's mouth far back onto the tongue. The holder of the sheep closes its nostrils and mouth tightly, and the syringe operator then discharges the dose as quickly as possible with maximum pressure on the plunger. With proper organization and care, three men can treat from 200 to 400 head an hour by this method. Capsules may also be used, but there is some disadvantage to them as they must be large to hold the required dose, or two smaller ones must be given. Capsules are also more expensive than the drench. Phenothiazine may also be given in feed. It should be mixed at the rate of an ounce of the drug to a pound of ground feed, and the amount of feed should be allowed that will provide the proper dosage of the phenothiazine.

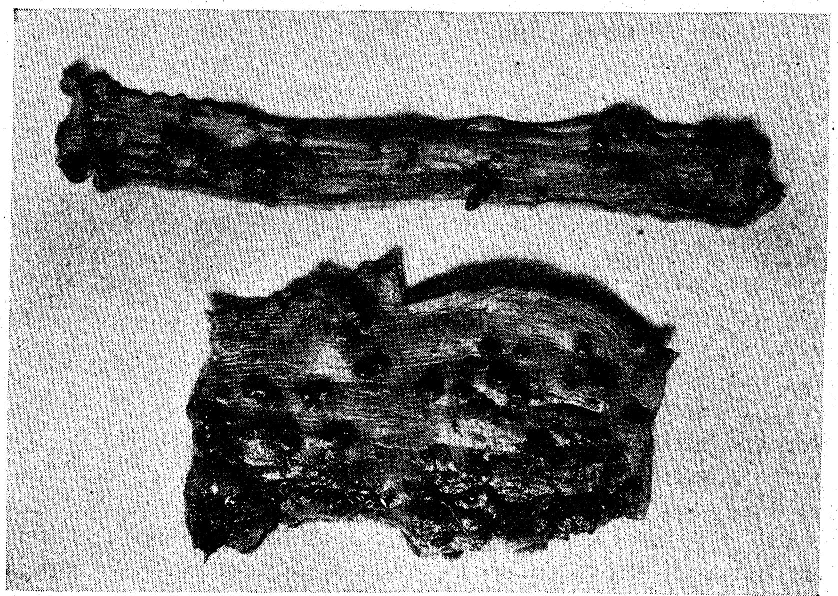
The dosages recommended are approximately one-half ounce for lambs and one ounce for yearlings and older sheep. The dosages are the same regardless of the method of administration. There is little if any difference in the effectiveness of the material, no matter

how given. The treatment may be repeated at about monthly intervals if necessary, but a more convenient method, and sufficiently effective under most conditions, is to treat the entire flock in the fall or early winter and again in the spring before turned onto new pastures. The lambs need not be treated in the spring. Throughout the pasture season the flock should have access to a mixture of phenothiazine and salt. This should be the only source of salt. The mixture may consist of one pound of phenothiazine to from nine to fourteen pounds of salt. This will aid in controlling infestation during the summer, as the small intake of phenothiazine will reduce the hatchability of any eggs produced by the stomach worms. It will not, however, prevent lambs from becoming heavily infested if they are pasturing on heavily parasitized grounds. The fall and spring treatments should be repeated each year along with the use of the mixture of salt and phenothiazine. This mixture should be kept in boxes protected from direct sunlight and rain.

Pasture rotation is always a rational feature of farm-sheep raising, not only from the standpoint of making the best use of pasture but as a means of holding infestations of internal parasites at a minimum. The use of phenothiazine as outlined combined with good pasture management and other good practices will make possible the development of a more successful sheep industry in many areas than has been attainable for many years.

Smaller round worms. There are several smaller roundworms that are commonly found in sheep that are infested with the twisted stomach worm. These include species designated as Ostertagia circumcincta and trifurcata, that are small, brownish, hairlike worms, about one-half inch long, that live in the abomasum. The life history outside the host is similar to that of the common stomach worm. The larvae cause considerable irritation to the mucous lining of the stomach.

Other species of small trichostrongyles, about one-fourth to one-third inch in length, are frequent inhabitants of the fourth stomach and small intestines. Although they are often present in fairly large numbers, they are often overlooked on post-mortem examination because the larger species attract attention. The life history of these parasites is similar to that of the stomach worm, but they seem to have greater resistance to unfavorable conditions in that part of the cycle spent outside the host. Infection is marked by severe unthriftiness, diarrhea, and anemia.



Courtesy Agricultural Research Administration, U.S.D.A.

The nodules on the intestines are due to nodular worm infestation.

Cooperias. Several species of a group of parasites classed as Cooperias are also similar to the trichostrongyles in size and in the effects on lambs and sheep. The life history of these, too, is not greatly dissimilar to that of species discussed in more detail.

Nematodirus. Still others that can be differentiated only by microscopic examination are found in the small intestines. These are known as thread-necked worms or Nematodirus. It seems likely that at least some of these species are not harmful, even when present in large numbers, if the animals are getting good feed and care.

Hookworms. In some sections of the country hookworms cause damage similar to that brought about by infestation of stomach worms. Hookworms are from a half to one inch long, nearly as thick as an ordinary straight pin, and are white in color.

While the treatments suggested for stomach worms may not destroy all of these species, such treatments are all that are available at present.

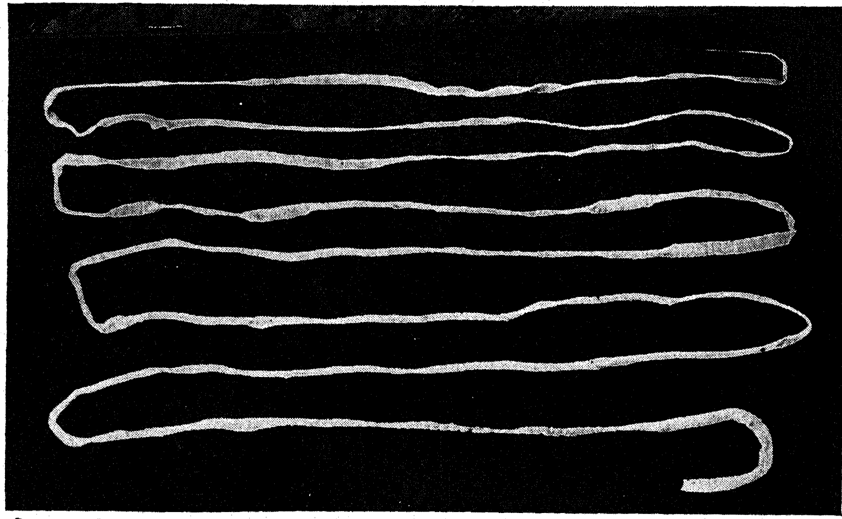
Nodular worms. Nodular worms (Esophagostomum columbianum) are found in many sheep in the United States, although

the infestations are usually much greater in the central and eastern humid areas than in the drier sections of the West and Southwest. In some sections other species of nodular worms infest sheep. The symptoms in severe cases are those of general parasitism. These worms are the cause of the nodules, knots, or concretions found on the intestines and sometimes other parts of the interior of the body. In packing-house parlance these nodules are referred to as "knotty guts."

The life history is similar to that of the stomach worm, as the eggs are passed in the feces, and after developing to an infestive larval stage, they complete their development in the walls of the intestines where they are taken as the sheep graze. After the larvae reach the intestines, they emerge from their covering and burrow into the intestines, penetrating to the muscular layer. Whitish cysts form about the parasites. These cysts become filled with hardened whitish and greenish materials around the larvae. When the larvae leave the cysts the nodules remain, and hundreds of them may be found in lambs and sheep, but usually there are not a great many live mature worms to be found, as they are apparently carried out with the feces. Damage seems to be due to tissue destruction, interference with normal intestinal functions, and perhaps to the poisonous materials of the larvae that are absorbed by the animals.

Phenothiazine, tetrachlorethylene, and the mixture of copper sulfate and nicotine sulfate, in the order given, seem to be the most effective materials. None of these are capable of destroying the larvae in the cysts. The use of phenothiazine in the manner outlined for stomach worm control is recommended.

Whipworms. Whipworms, technically known as Trichuris ovis, seem to cause some trouble in lambs. In the author's experience a heavy infestation in lambs seemed to be associated with a persistent diarrhea and unthriftiness. The worms are usually found attached to the caecum, or blind pouch, of the large intestine. The worms have a very slender anterior portion and much enlarged posterior. The worms are attached to the wall of the intestine by the head, which is at the tip of the slender portion. They are about one and one-half to two inches in length. There are inflamed areas about the point of attachment to the intestine. The life history of the whipworm is simple and direct—that is, no intermediate host is necessary to complete the cycle. Sheep become infested by swallowing the eggs or larvae when grazing. Since the parasites are



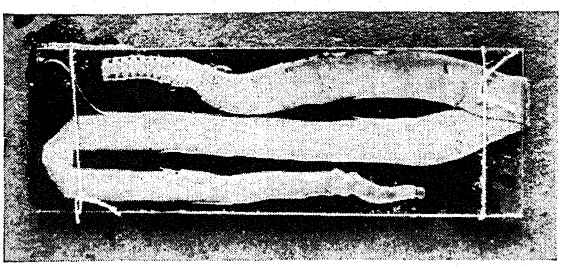
Courtesy Colorado A. and M. College

This is the common tapeworm.

located so far back in the intestinal tract, treatment is difficult and relatively ineffective.

Tapeworms. Tapeworms of several different species may infest sheep, and they seem to be found in all parts of the world. The common tapeworm, Monezia expansa, has an elongated, flat body composed of a number of segments or parts, and as some of these "ripen" and break off, new parts are being formed at the other end of the body just back of the head. These segments, usually about one-half inch wide and whitish in color, may be seen clinging to the feces. It has been shown that some of the eggs are carried in these pieces. There is doubt about all the stages needed for complete development. In some species at least it is likely that an intermediate host is necessary before sheep may be reinfested.

Tapeworms of the Monezia expansa species may attain great lengths, and although the usual length is not often more than several feet, specimens of more than twenty feet have been seen in lambs. The adult tapeworms live in the intestine. The effect of this species on the host is often less marked than when other parasites are present, but some harm is probably done. Although symptoms of parasitism may be observed, those may be due to simultaneous infestation with other parasites. In the central areas it is



Courtesy Colorado A. and M. College

This is the fringed tapeworm.

not often that more than a few members of the flock are infested at one time. Tapeworm-infested animals usually have normal appetites.

There is a more destructive type of tapeworm known as the fringed tapeworm (Thysanosoma actinioides), that is rather common in western parts of the United States. Its life history is not known, but it is thought to require an intermediate invertebrate host through which it must pass before it can infest sheep. The absence of this host in some areas would explain why it is more frequently found in some places than in others. The fringed tapeworm is found not only in the small intestines but often in the gall ducts, gall bladder, and in the canals of the liver and pancreas. When it causes a stoppage of these ducts, the animals may die, but usually there is only loss of flesh and vigor due to impaired digestion. Livers that are infested are not considered suitable for human food.

The cunic mixture—copper sulfate and nicotine sulfate—will remove the tapeworms from the intestines; but there is no way to remove the fringed tapeworms from other areas.

Coenurus cerebalis. Sometimes cysts containing the larvae of the tapeworm eggs voided by dogs or other carnivorous animals are found on the brain or in other parts of sheep. These eggs are eaten by the sheep, and the embryos that emerge make their way into the blood stream and are carried to various parts of the body. Apparently only those of one species, Coenurus cerebalis, that reach the brain survive and complete their development, which may require about seven or eight months. A cyst or bladder on the brain contains the gid, or gid bladder worm. If there are many embryonic worms present in the brain in the early stages, the animal may die. If it does not die, there may be no symptoms until four or five months later when there will be defects in vision and disturbances in movements. The animal may stumble, run into objects, walk

with the head high or in circles, and there may be at least a partial paralysis of the hindquarters. There is no treatment for "giddy" sheep.

Cysticercus ovis. Tapeworm larvae of another species, Cysticercus ovis, are responsible for the condition known as "sheep measles." This bladder worm infests sheep in many parts of the United States. Eggs passed by infested dogs are eaten by sheep and pass in the blood stream to those parts of the body where the cysts are found on post-mortem examination. It seems unlikely that many sheep die because of the presence of "sheep measles," but heavily infested carcasses are not considered suitable for human food, although the parasite is not transmissible to man. Parts of lightly infested carcasses are cut away. The diaphragm, heart, and muscles may harbor these bladder worms. The thin-necked bladder worm causes a similar condition in the liver or in the thin membranes of the abdominal cavity.

Lungworms. Lungworms of two species, Dictyocaulus filaria, or thread lungworm, and Muellerius capillaris, or hair lungworm, are frequently reported as infesting sheep in the United States. There are some differences in the life cycle of the two species, but in general the adults lay eggs in the air passages of the lungs, and there they develop into larvae. The larvae reach the upper part of the throat and may be expelled when the animals cough, or they may be swallowed and then be passed with the feces. The thread lungworms molt twice and reach an infective stage in about ten days. It seems probable that the hair lungworms pass part of the life cycle in certain snails which may be eaten by sheep, and the larvae are then liberated and reach the lungs in much the same manner as those of the thread lungworms: by boring through the wall of the intestine and passing through the lymph system to the lungs, where in a little more than two weeks they reach the adult stage. The thread worms are white in color and may be as much as four inches in length. The hair lungworms are much thinner and shorter.

The thread lungworm seems to be much more important from a disease standpoint than the other, as there may be no special symptoms associated with an infection of the hair lungworms. The thread lungworms cause considerable irritation, and the first symptom is coughing. In very heavy infections the breathing is rapid and difficult because of the blocking of the air passages and the inter-

ference with the functioning of large areas of the lungs. The sheep become listless, thin, and may die in the course of two or three months. The chief effect seems to be mechanical, and death probably results from suffocation or from pneumonia which develops as a result of the irritation and impaired function of the lungs.

To date no thoroughly satisfactory treatment for lungworms has been developed. The inhalation of sulphur fumes or chloroform has been suggested and a fair degree of success reported in a few cases, but there is too much danger in the method for it to gain wide usage. The administering of intratracheal injections is beyond the skill of any but experienced veterinarians, and the effectiveness is not high. It is the belief of some that phenothiazine may have some effect in reducing lungworms, through the lowering of the survival rate of the larvae as they pass through the alimentary tract. Cures sometimes occur without any readily apparent reason, perhaps because the adults do not persist for a long time, and if reinfestation does not develop, recovery may be quite complete. Good feeding and management and the avoidance of wet areas in pastures aid in reducing the trouble.

Liver flukes. Liver flukes, Fasciola hepatica, are very numerous in sheep in some localities, especially in some of the areas of the western and southwestern range country, and they may be brought into other areas through the purchase of sheep and lambs. There are other species of flukes. The distribution of the common liver fluke is world-wide wherever there are low, wet pastures and suitable types of snails occur. Flukes reproduce by means of eggs which, after passing from the host, hatch into embryos that are equipped with cilia that enable them to move about. When these embryos encounter certain kinds of snails, they penetrate into the body of the snails. Additional development occurs within the snails, after which the embryonic flukes, now known as cercariae, leave the snails and become encysted on the nearby vegetation. In several of the stages the flukes are resistant to environment and may remain infective for a period of some months. When eaten by sheep, the fluke escapes from the cyst, burrows through the intestinal structures, wanders about in the body for a time, and finally reaches the liver. Here, maturity is attained two or three months after infection. Mature flukes are flat, leaf-like parasites about an inch long and of a brownish color.

Death may occur without any definite symptoms being shown

by the sheep if the flukes are present in very great numbers. If death does not occur, the usual symptoms are those generally found as an accompaniment of parasitism. Sometimes there may be a distinct potbellied condition because of the escape of fluids into the body cavity due to damage to the liver. The flukes may be so numerous as to stop the flow of bile, and the ducts may be greatly enlarged.

Carbontetrachloride has been the most effective treatment against flukes, but this is effective only against the mature parasites in the bile ducts. There are occasionally bad effects from the administration of this material, and the advice of a veterinarian should be obtained. *The Report of the Bureau of Animal Industry for 1945* states that a suspension of hexachlorethane and bentonite has been found effective in 104 cases of 110 animals treated.

The life history of the fluke gives a clue to its control. The avoidance of low, wet pastures where the snails that harbor the flukes are found is of course suggested. Drainage of such areas will reduce the number of snails, and hence of flukes. Further, copper sulfate in very small quantities will kill the snails. A dilution of one part of copper sulfate to 1,500,000 parts of water will destroy snails in a very short time, but it is sometimes used in greater concentration. The chemical does not kill the flukes; it only destroys the intermediate hosts. Treatment of snail-infested areas is generally needed at least once a year. Springtime is the preferred season for treatment.

Fluke-infested livers are often referred to as having the "rot" or "rotten livers" in slaughter plants. The economic loss from damage to this organ is considerable.

Blowflies. Blowflies are a distinct problem for the sheep raiser. Some species of blowflies are found throughout the United States, but one of the most troublesome, the screwworm fly, is restricted to a normal range within the southern and southwestern states. Under especially favorable conditions the screwworm fly may be found as far north as central Illinois. It is one of the most destructive pests the sheepman must contend with, as it is so readily attracted to newborn animals; to man-made injuries on animals that occur at shearing, docking, castrating or other times; or by injuries of any kind that result in a break in the skin. This fly may be seen on dead animals, but is most frequently seen feeding and laying its eggs on live animals. The screwworm fly is very hard to

distinguish from some of the other types of blowflies which have similar habits but differ in the way they multiply. The screwworm can breed only in the warm tissues of living, warm-blooded animals. Other blowflies may develop in decaying carcasses, although they also infest wounds or filth-covered areas of live animals. The black blowflies, or wool-maggot flies, produce injuries similar to those caused by the screwworms, but the latter burrow considerably deeper into the flesh. The wool-maggots spread over the body, causing great irritation and destroying the ability of the skin to function. Sheep that have soiled or wet wool are especially susceptible to blowfly attacks. Sometimes the wool about the base of the horns of fine-wooled rams is "fly blown," and lambs that scour are very likely to be "struck."

The eggs of flies are visible about the edges of wounds or on the befouled areas. The eggs hatch in a few hours, and the maggots begin feeding at once. When they have attained full growth, they leave the wound and drop to the ground where they complete their development. In severe "strikes," death of the sheep follows if treatment is not prompt and effective. An attentive caretaker will easily detect "struck" animals by the restlessness and peculiar twisting and squirming as they rub and try to bite the irritated parts.

Treatment consists of clipping the wool from about the infested area and applying something that will kill the maggots. For this purpose sheepmen have used a great variety of materials. The ideal treatment would be one that would destroy the maggots and at the same time afford protection against reinfestation. The United States Department of Agriculture recommends Formula MS 62, which utilizes benzol and diphenylamine for these purposes. This preparation may be made by mixing the following materials in the proportions indicated, or it may be purchased already prepared.

Materials	*Parts by weight*
Diphenylamine (technical grade)	3.5
Benzol (90% commercial)	3.5
Turkey-red oil (sulfonated castor oil)	1.0
Lampblack (Germantown)	2.0

The mixture is about the consistency of paint and is applied to the

infested areas with a small paint brush or flat stick. It will often take two applications a week until the wounds have healed. Pine tar or pinetrel are more effective repellents than the above.

The sheep nasal fly. The sheep nasal fly, Estrus ovis, also called gadfly, is the adult form of the grubs found in the heads of sheep. The fly is a dark-yellow or brownish color, hairy, and is bigger than the common fly. These flies deposit larvae instead of eggs. The larvae are deposited around the sheep's nostrils, from where they crawl up the nasal passages to the sinuses. It is in these passages and sinuses that the larvae are found. They are commonly called grubs, and the condition due to them is referred to as "grub in the head." The flies are very annoying to sheep, causing them to stamp their feet, run about, duck their heads, and rub their noses in the dust or hold them close to the ground. The flies are most active during the warm part of the day, during the summer months. The larvae cause considerable irritation and discomfort. Sheep that are infested with grubs usually have a heavy-mucous nasal discharge. There is frequent sneezing during which the head is drawn back as the animal tries to dislodge the grubs. The eyes may be inflamed, and there is loss of appetite. It is unlikely that the grubs themselves cause death in many cases. It also seems likely that the immature larvae represent the over-wintering stage of the flies.

Many farmers have used pine tar smeared about the nostrils of the sheep as a repellent to the flies. Various devices have been used to get the sheep to make their own applications of the tar, although in small flocks the owners usually rub the tar on by using a leather glove or a small paddle. Workers in the United States Department of Agriculture report that such repellents are not very effective. Many efforts have been made to treat sheep for the removal or destruction of the grubs. Most materials are difficult to apply and have not been considered of widespread usefulness. The most recent recommendation is that of Cobbett,[1] who injected a 3 per cent solution of saponated cresol into each nostril under considerable pressure. This is quickly done by placing the sheep on its side or back and holding the head at an angle to facilitate administration. It is reported that a single treatment killed 90 per cent of the larvae, and two treatments killed as high as 98 per cent of them. Special equipment is suggested for treating large numbers of sheep. The treatment is most effective in reducing the numbers

[1] Cobbett, N. G. U.S.D.A. Mimeo. 1941.

of flies in those areas where the winters are too cold for the flies to live over except in the larval stage.

Plant poisoning. Plant poisoning is not infrequently encountered in sheep. There are many species of plants that at certain stages contain poisonous materials. Fortunately, many such plants are not readily eaten when other forage is available. Some plants cause violent poisoning, and death occurs in a very short time; others cause a slow progressive loss of flesh and weakness. Special publications deal in detail with these plants.

The best method of prevention is keeping animals from grazing the dangerous herbage, but this is difficult under conditions of scant pasturage or when the sheep have become hungry because of long drives or have been without feed due to other circumstances. Eradication of the plants is impossible except on farms where areas are limited. In the range areas where poisonous plants are most numerous, eradication is impossible; some help may be secured through judicious use of the range so that desirable forage is kept abundant, and other plants are held in check to some extent. Deferred and rotation grazing are helpful, as these may be used as a means of range improvement and also may help to provide grazing areas free of poisonous plants when poisonous plants in other areas are passing through the dangerous stages. Many plants must be avoided for relatively short periods.

Even some of the cultivated plants or their products may be poisonous under certain conditions. Thus, the Wyoming Station has reported oat hay wet with rain or snow as poisonous. Sudan grass and sorghums are also dangerous when in some stages of growth or are freshly wilted. It is necessary to remember that suspicion does not prove a plant as being the cause of loss of animals. Some plants are "suspects," but not all have been proved dangerous. Thus cockleburs are said to be poisonous when in the two-leaf stage of early growth, but the poisonous period is shortly after the seeds have germinated,[1] and since this occurs in the spring when other feeds are palatable, the danger in most cases is not great unless the sheep are confined to an area where they eat the shoots as they emerge from the soil.

The following plants are listed as containing hydrocyanic acid—a violent poison—under certain conditions: Chokecherry, Blackcherry, Sudan grass, Johnson grass, Sorghums, Flax, Arrow

[1] U.S.D.A. Cir. 283.

grass, and Christmasberry. Other plants that have apparently caused poisoning in sheep are aconite or monkshood, some species of barberry, heavy concentrations of algae in water, Black Henbane, Deathcamas, various ferns, some of the goldenrods, hemlock, lupine, whorled milkweed, possibly some species of oak when eaten in large amounts, white snakeroot, sneezeweed, woody aster, nightshade, and others. In most cases some specie of a plant will be poisonous, but others of the same specie may not be. It is difficult if not impossible for the sheep raiser to differentiate between the species and know which are harmful.

Other groups of plants that are harmful are those which have awns or spears that do mechanical injury. These spines may become embedded in the tissues of the mouth or get into the eyes, or some may pierce the skin and enter the flesh, thus damaging the carcass. Among plants of this kind are many that have seeds borne in burrs. Some grasses such as downy brome grass, needle grass, poverty grass, wild barley, and wild oats cause much damage. These are especially troublesome with very woolly-faced sheep. All cases of sore eyes where such plants are growing should be examined for the presence of parts of these plants embedded in the eyes. In some areas the spines of cacti cause great difficulty, especially when the forage is short, due to drought.

Predatory wild animals and dogs. Predatory wild animals and dogs are a constant menace to sheep and other livestock producers. These are discussed briefly in other sections.

CHAPTER 41

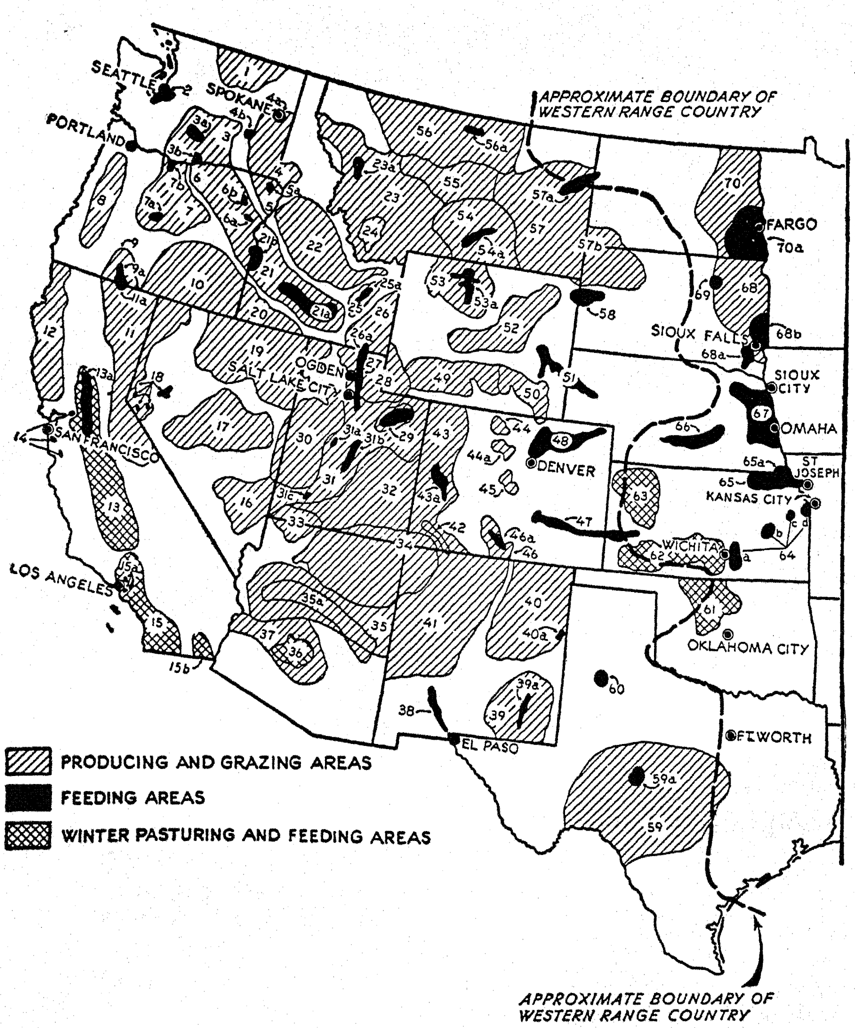
★ *The Western Range Area* ★

Special attention is given to the western-range sheep industry because it is within the range area that approximately 70 per cent of the sheep of the United States are found. It is also within this area where the great lamb-feeding sections are located, although many sheep are raised and many lambs fed in other sections. While special attention is given to this area, there are many more similarities with respect to sheep and sheep raising in all sections than are generally supposed.

Size of an enterprise may introduce new problems, but that does not mean that there is much difference in the units which make up a large or a small enterprise. Sheep and their fundamental nature remain the same in any locality. Large flocks are much more spectacular than small ones, and the former may be the sole or chief source of income for the owner, while the owner of the small flock may derive as much or more return from other activities as he does from his flock. Feed is as important under one condition as another. Health hazards may be different in the two cases, but in either case health is a matter of great importance. Likewise, the matters which determine rate of growth, kind and amount of wool, and market value are similar.

This view is somewhat contrary to the general idea which many people have of the industry in the two sections of the country. There is no intention to minimize the differences; the intent is to emphasize the similarities. Success in any area depends upon a highly productive flock properly and economically managed, together with careful attention to advantageous marketing of the lambs and wool. The effects of external factors may be greater under some conditions than under other circumstances, but the effects will be experienced by all producers in all areas.

Range area. The range area includes parts or all of seventeen states lying west of an irregular line which cuts through the Da-



From Circular C-103, Farm Credit Administration

This map shows the principal areas of sheep production, grazing, and feeding in 17 range states. Variations in climate and feed are partly responsible for differences in the kinds of sheep raised and in time and place of marketing.

kotas, Nebraska, Kansas, Oklahoma, and Texas. The total land area of these states approximates 975 million acres, of which some 728 million acres comprise the range sections. This is practically 40 per cent of the total land area of continental United States. While there are other uses for the area, most of it is available to some extent for livestock grazing. The grazing portions are used for other classes of stock besides sheep. Not all of the area is used by sheep raised under range conditions, as farm-sheep raising is carried on to some degree in all of these states.

There are as great or greater differences in soils, topography, vegetation, climate, and other factors within this vast region as there are between the range section and other parts of this country. It is because of the great variations within the region of the range that there is no standard type of sheep raising carried on in all sections. Types of sheep and methods of management are decidedly varied. In numerous instances, individual producers may raise a type and quality of sheep and follow management practices which do not correspond to the general description of an area.

History of range industry. The development of the livestock industry of the western part of the country constitutes one of the most fascinating parts of the story of the nation. When sheepmen first went to the region, the entire country was "open," and such "priorities" as existed were based largely on first come first served. Competition developed for the land and its forage among the cattlemen and the sheepmen, and many conflicts were settled at the cost of human as well as animal life. Strife centered about the control of "water holes" and previous occupation. Resentment was certain when these premises were trespassed upon. It is true that there were conflicts between the sheepmen and the cattlemen, but it is equally true that all was often not peaceful between rival sheep or between rival cattle outfits.

Many people saw in the vast land areas the possibility of uses other than for grazing, and the coming of the homesteaders and the railroads caused great changes. The control of the water failed to give immunity to the sheepmen from the inroads of the farmers. The homesteaders put up fences which obstructed the driveways for the sheep raiser, and since the fences were not sufficient to keep the animals from getting through and eating some of the crops, the farmers collected damages or compelled the grazers to pay rents for their privileges. Vast areas of land were given to the railroads

and states, and these, too, collected fees from the sheep raisers. There followed other changes such as the creation of the national forests and grazing districts, and these, too, had profound effects upon the sheep industry, for with them came many rules and regulations, all of which had the effect of restricting freedom of operation and increasing costs of production. Today, little free land is available, and the rangemen are faced at every turn with some item of cost. Such changes have not been imposed upon the sheepmen alone, for there is no industry today which operates under the same conditions which existed formerly for the simple reason that such conditions no longer exist.

Geographical divisions. The range area is often divided into three large sections which differ mainly with respect to climate, although there are variations within the areas, and there is no sharp line of separation. There are also differences in methods of management and, to some extent, in the kind of sheep kept. These divisions are: (1) the southwestern area which includes Texas, New Mexico, Arizona, and southern Colorado; (2) California; and (3) the northwestern area which covers Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Nevada. There are other ways in which the area is divided. The states and parts of states that lie within the Rocky and Sierra Nevada Mountain Ranges are often spoken of as the Intermountain region. There are also the Great Plains region and the Pacific Coast section. In addition to these divisions there are many other divisions on a smaller basis. Altogether, there are more than seventy distinctly recognized areas in the range states where sheep are raised and fed.[1]

In all of these divisions there are various types of lands. There are several different classifications of lands. One of the common classifications is on the basis of general topography into plains, foothills, and mountains.

Plains. The plains areas comprise millions of acres of flat or gently rolling lands which seem to stretch endlessly in all directions. The plains are arid or semi-arid and from a vegetative standpoint are characterized by sparse-growing grasses and low-growing shrubs. The forage is apparently palatable, and while not highly suitable for the production of rapid-growing fat lambs, it serves well for the maintenance of vast numbers of sheep, especially during the winter season. In grazing, the sheep travel great distances

[1] Cir. No. C-103 Farm Credit Admin. 1936.

Courtesy Grazing Service

Millions of acres of land not usable in any other way are grazed by sheep and cattle.

in a day, and the area required to maintain one sheep for a few months may vary from about three to more than twenty acres. Some of the plains-type country is, in reality, desert, but even this may provide feed for many sheep. Even though the rainfall in such areas is very light, there are noticeable differences in the amount of feed from year to year. The major factor in creating such differences is the amount of rainfall. Much of the plains and desert areas receive only 5 to 15 inches of rainfall annually, and more than 20 inches is very rare.

Foothills. As the mountains are approached from the plains or desert sections, there are great areas known as the foothills. Here, there may be more precipitation and forage of a greatly different character. These foothills furnish much of the feed during the spring and fall seasons, and the range is often spoken of as spring and fall range. Compared with the plain and desert vegetation, that growing on the foothills is more luxuriant and succulent, and hence is more stimulating to such functions as milk production by the ewes and growth in the lambs. These areas also have numerous places where the sheep may find water which has accumulated from rains or from the melting snows.

Mountains. The best summer ranges are located in the mountains where the vegetation is varied, palatable, succulent, and nutritious. These mountain areas are cool and generally well sup-

plied with water. Lambs make considerably more growth on mountain than on plains feed. The best lambs marketed direct from the ranges as fat lambs are raised in mountain sections. This is the typical summer range for the flocks of the western sheepmen. Much of the area can be used only from about mid-June or the first of July until some time during the month of September because of the heavy snowfall. The mountains are the areas of heaviest precipitation. These snows provide water for the vegetation and also make possible the irrigation of large areas for the production of crops, many of which are used as supplementary winter feeds. Most of the national forests are in the mountainous country.

Cultivated lands. There are two types of cultivated lands in the range country. Dry-land farming is practiced on great areas. Wheat is the main crop produced in this way, and during the early growing season it may be used as a pasture for sheep. In some areas moderate pasturing is considered beneficial to the wheat as well as a source of excellent feed for sheep.

Irrigation farming has been increased in practically all sections where water for such purposes is available from streams or has been made available through the construction of great reservoirs. The by-products of such farming, as, for example, sugar beet tops and pulp, are used extensively as supplementary winter feeds. Thousands of acres of alfalfa and other hay and pasture crops are also grown on irrigated lands. With the growth of population in the western states, the competition for such feeds is increasing, and here too the modern sheep raiser finds he is faced with rising costs, compared with those of the earlier operators.

Types of vegetation. The range area may be classified on the basis of the kind of vegetation which is most prevalent. On this basis the classification includes areas characterized as tall grass, short grass, Pacific bunch grass, semi-desert grass, sagebrush grass, southern desert shrub, salt desert shrub, piñon juniper, woodland chaparral, open forest, and dense forest.

Tall-grass area. Within the limits of the present range area there are about 42 million acres which produced tall-growing species of grass. Not all of this area is in such grasses today, for there have been many changes caused by the coming of the settlers and by changes in methods of management. The dominant native vegetation varied with the soil, topography, and rainfall, but there was always some tall grasses. Bluestem, big and little, Indian grass, wild

rye, side oats grama, slough grass, and the bunch-forming dropseed grow on much of the area. These are interspersed with weeds and shorter grasses. On this particular type of range cattle rather than sheep raising predominates. Although sheep raising does continue, the vegetation is considered more suitable for other stock.

Short-grass area. Short grasses cover an area of 280 million acres in a belt that extends from Texas to the Canadian border, with a width of more than 300 miles. On the west the short-grass country extends to the foothills of the Rocky Mountains. This vast area is not covered with a uniform vegetation, but most of the grasses are of species which require relatively little rainfall. Grama, buffalo, wheat grass, and others, with a generous admixture of palatable, herbaceous plants, are among the most prevalent types. These plants, especially in Wyoming and Montana, grow among clumps of sagebrush. Most of these short grasses mature early after a relatively short growing season, for the area is generally at a higher elevation than the tall-grass section. Even when matured the leaves remain as valuable forage, for there is little leaching or loss of nutrients from other causes, compared with the losses which occur in the more humid regions. The short-grass area is more important in sheep raising than the section characterized by the tall grasses.

Pacific bunch grass. The bunch-grass type of range is found chiefly in western Montana, eastern Washington and Oregon, southwestern Idaho, and central California. The bunch grasses are fairly tall but grow in tufts or bunches. Among the grasses of this type are some of the wheat grasses, Idaho fescue, wild rye, bluegrass, junegrass, and others. About 60 million acres in the above areas are covered with forage of this type. Along with the grasses are some palatable weeds which add greatly to the forage supply.

Semi-desert grass. This area of about 93 million acres has some short grasses, but it is characterized chiefly by the scraggly shrubs and low trees such as the creosote bush, mesquite, hackberry, scrub oak, and others. The most common grasses are grama, black grama, and curly mesquite. Although these are widely distributed, they are generally sparse, and interspersed among them is the prickly pear and other cacti, yucca, and other plants which survive under conditions of very scant rainfall. In general, this area of semi-desert grass extends through southwestern Texas, New Mexico, and Arizona. The feed is not sufficient to nourish lambs and ewes so

that the lambs will grow rapidly and attain market finish without other feed.

Sagebrush grass. This is one of the most important of the types of range, as it covers between 90 and 100 million acres, and the sagebrush and intermingled grasses provide great quantities of grazing forage. There is much variation in the density of growth both of the brush and the grass. To the uninitiated, the brush is apt to appear of only one type and of no value. But there are several kinds, and while it does not supply the most nutritious feed, it is browsed by sheep. As a rule sagebrush plants grow several feet or more apart and attain a height of from about two to seven feet. It has some importance as a windbreak for ewes and lambs as well as for feed. Range improvement is sometimes effected by the removal of the brush to encourage greater growth of grasses. The sagebrush-grass region has many species of grasses among which are wheat grasses, fescues, wild rye, rice grass, and numerous species of weeds, which when in bloom give the area broad dashes of brilliant color. Many of the weeds are palatable and nutritious; some are poisonous. This type of vegetation is found on the plains sections and also extending far up on many of the foothills.

Southern desert shrub. More than 50 million acres with sparse vegetation are included in this general region. It is characterized by very scant rainfall and extremely high temperatures. There is little uniformity of plant cover, and much of the area has little or no grazing value. Aside from infrequent areas where some grass may be found, most of the growth consists of weird forms of cacti and of the desert salt-bush or similar growth. After rains there may be a multitude of quick-growing, bright-blossomed flowers. The area is chiefly in eastern California, southern Nevada, and southwestern Arizona. It is one of the least important of the general-vegetation-type areas from a sheep-raising standpoint.

Salt-desert shrub. About 40 million acres in southwestern Wyoming, southern Idaho, Utah, and Nevada are covered with a mixture of low shrubs and scattered grasses. Various species of sage and rabbit brush and grasses such as wild rye, rice grass, squirrel-tail, and bunch grasses comprise the dominant vegetation. Soil conditions vary greatly in this region. In some extensive areas the alkali content of the soil is so great that there is only the extremely sparse growth of a few shrubs and weeds, which are of no value for grazing. In sections with better soil the vegetation is much denser, but

there is seldom such density of grasses that the term sod would be used to describe it. In most areas not more than 30 per cent of the ground has any vegetative cover. Nevertheless, because of the extent of the desert area of this type, winter grazing is afforded for many large flocks.

Piñon juniper. This is the transition zone from the shrub and grass areas of the lower elevations to the forests of the mountains. It is found through much of the foothill region where the trees are chiefly piñons and junipers. These are usually about 20 to 40 feet tall, and as they generally grow rather far apart, there is also considerable shrub and grass growth. Mountain mahogany, bitter brush, and grasses like grama, mountain bluegrass, needle grass, and wheat grass furnish much browse and forage. Sheepmen use areas of this type for spring and fall range.

Woodland chaparral. In some parts of the range area, especially in parts of California and Arizona, there are vast brush areas which in some places are almost impassable thickets. These "chaparral" thickets are of no value for feed. But in some places the growth is less dense, and in such woodland sections there are "parks" with many nutritious grasses and other plants.

Open forests. Throughout the 130 million acres of open forests found in practically all of the mountain ranges is an abundant growth of many species of shrubs, grasses, and other plants. Among the more common grasses may be listed blue grama, fescues, bluestem, wheat grasses, timothy, bluegrasses, sedges, and dozens of others. Many of the other plants are leguminous and hence are likely to be palatable and nutritious. This plant growth coupled with the climatic conditions of these high elevations combine to give these open-forest areas great importance to the sheep industry. It is here that the sheepmen find the best of summer grazing for their flocks, which, properly used in connection with the spring and fall range of the foothills and the winter range of the deserts, make possible the yearlong grazing cycle for sheep and other livestock as well. Under careful management, here is found rotational or seasonal grazing at its best, and it is an emulation of this for which the producers in other sections strive.

Dense forest. While this is an important part of the range country containing almost 70 million acres, it is only in the open spaces within the forests that any sheep are grazed.

Ownership and supervision of the range. Some of the prob-

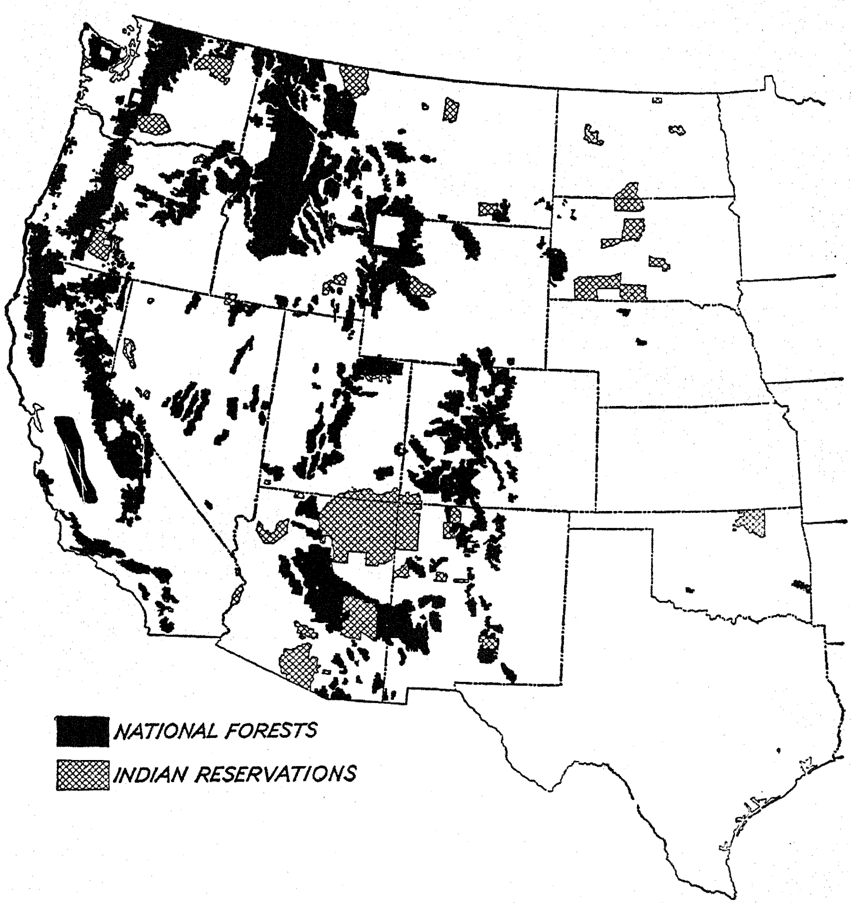
lems of the sheep raisers are brought about through the ownership and supervision of these vast amounts of land. At one time practically all of the region was owned by the Federal government, but this has been changed "into a bewildering mosaic of intermingled state, county, municipal, private, federal, and other ownerships. Even the land in federal ownership or control is under various jurisdictions, such as the national parks and monuments, national forests, Indian lands, grazing districts, and unreserved public domain." The policies under which the various lands are administered differ, and from these differences have arisen some annoyances which have not been looked upon with much favor by the sheepmen. The areas under various types of ownership are approximately as follows:

TABLE 54

OWNERSHIP OF THE RANGE AREA

	Acres	Available for range use
Federal		
National forests	87,954,000	82,538,000
Public domain, grazing districts	127,792,000	127,792,000
Indian lands	48,391,000	48,391,000
Other	22,997,000	21,599,000
State and county	65,516,000	65,084,000
Private	375,546,000	375,546,000
Total	728,196,000	720,950,000

National forests. The national forests are under the supervision of the Forest Service, which prescribes the fees charged and regulations under which sheep and other animals may be grazed on them. In allocating grazing permits, preference has been given to owners of farms who can support stock part of the year on the products of the land which they own. No rights have accrued to the users, and some large users have had their permits reduced to allow smaller operators to use the forests for grazing. The relative number of permittees who run less than 1,000 sheep on the forests has increased considerably during the past twenty-five or thirty years. In 1934, 62 per cent of the permits were for this size of flock. During the same year there were only four permits to graze more than 4,000 sheep. More than six million head were grazed on the forests at that time.



From U. S. Forest Service, Circular C-103, Farm Credit Administration

This map shows National Forests and Indian Reservations in the western states. National Forests provide summer grazing for sheep and cattle.

The general intent of the regulations specifying how the animals may be handled is the conservation of the range resources. Many controversies have occurred regarding these matters. Climatic conditions have much to do with the amount of forage available. In general, the policy has been to under-utilize the forage at all times so that improvement in the amount and quality of forage would take place. Fees have been increased from time to time, and while not one of the major cost items of production, they do

constitute one of the factors in the rising costs of operation. The forests are not administered for grazing alone but primarily for the purpose of achieving "multiple use," which includes the promotion of forest growth, big game and other wildlife, recreation, and other matters. Most permits are arranged as close to the headquarters of the operators as possible, but the movement of sheep from winter to summer range often means long drives. Driveways are established for such purposes when possible.[1]

Grazing districts. The entire area of the public domain was formerly free-grazing land, and as such much of it was severely overgrazed and misused. In 1934 grazing districts were established which placed about one-half of all the lands owned by the Federal government under grazing control. The purpose of this act was to develop the areas so that those who do secure permits to use them will obtain much more benefit. Many changes have been brought about under the system, and some who made extensive use of these areas have been deprived of feeding areas to such an extent that severe criticism has been heard. This is countered by the statement that those who have grazing-district permits have a much more certain feed supply than formerly, and that many benefits in the general public interest are being accomplished. These districts are now administered by the Department of Interior, and the policies here are, at least in some instances, different from those of the Forest Service of the Department of Agriculture. This makes it more difficult for the sheep raisers, as they must deal with and account to more agencies. Complaints are heard that costs have been increased by this development. Some extensive range-improvement programs have been undertaken. Reseeding and other measures may restore all of the original feed-producing capacity of these areas. In fact there is a possibility that the early capacity may be exceeded in time through the development of better strains of grasses and the use of good practices. Many of the Indian lands and areas outside the grazing districts are not subject to grazing control.

State lands. Lands were granted to many of the states, and the total so held is approximately 65 million acres. Many of these lands have been grazed, some under lease and some without restriction. The management of such lands has not been uniform in the different states, but, for the most part, the established practice for many years had been one of first come first served. Overgrazing

[1] Sheep Migration. Cir. 624. U.S.D.A. 1942.

and depletion was not limited to any one type of ownership. Leases were generally for a one- or a five-year period, and the rental was only a few cents per acre, the rate depending upon accessibility, amount of water, and quality of forage.

Railway lands. For building their lines, the railroads were given large grants of land. These grants consisted of alternate sections extending for a distance of from 10 to 40 miles on each side of the right of way. Of the more than 94 million acres so granted, about 20 million acres are still held by the railroads. These are leased usually to land owners who have adjoining property, although not all of such lands are suitable for grazing.

Private lands. The range area has many large and many small holdings. Irrigation has made many small farm areas highly productive, but these have in some cases been obstacles to the operations of the range sheepmen and range cattlemen. Millions of acres of land were homesteaded in areas of 160 to 640 acres. Farms of that size without irrigation would not support a family. Many were abandoned, but these too were handicaps to stock production; in the light of experience, homesteading should never have been permitted, not only for what interference may have been caused to sheep and other livestock production but from the standpoint of land use and other policies as well.

Sheep raising adapted to range. Despite all of the criticism of stock raising on the ranges, it is undoubtedly the most legitimate agricultural enterprise for much of this vast area. Studies with respect to soil and water losses show that under proper conditions of management such losses may be kept at a "permissible minimum" and profitable livestock husbandry carried on. It is doubtful if natural resources of the range area have been misused to any greater degree by the stockmen than similar resources have been misused by others. Domesticated animals are inherently no more destructive than game animals may be. Poor management may make them so.

In the Intermountain region in 1938 and 1939, 33 per cent of the operators used grazing districts, national forests, and private lands; 39 per cent used grazing districts and private lands; and 26 per cent used national forests and private lands. It was estimated that the sheep obtained only 51 per cent of their forage on public lands because of the differences in productive capacity between the publicly and privately owned lands.

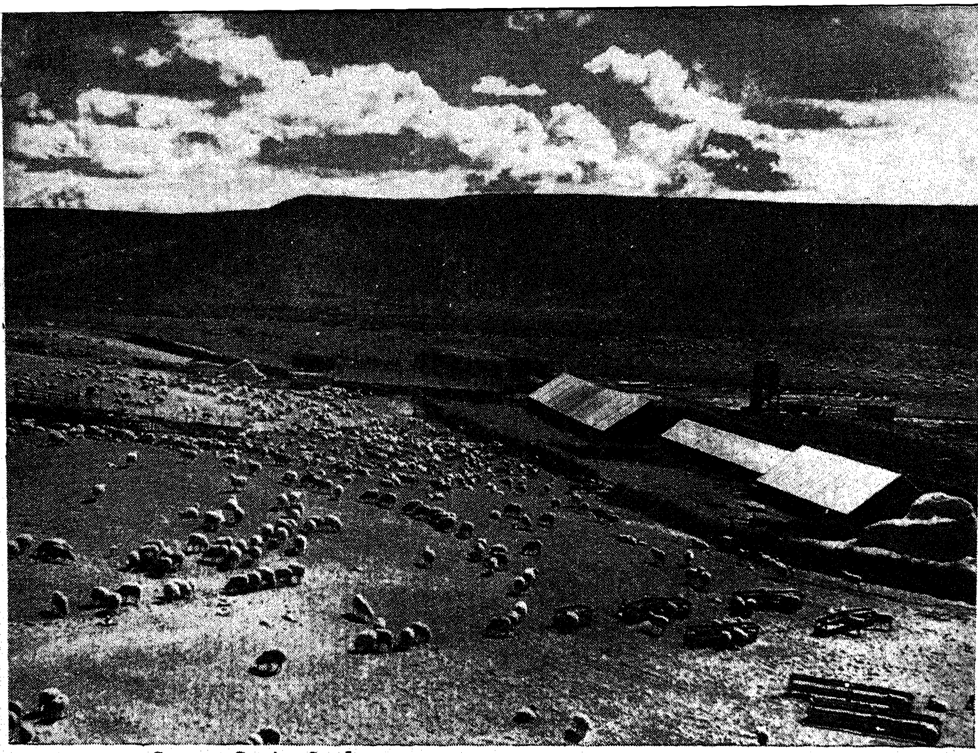
CHAPTER 42

Managing Sheep on the Range

There is no single standard method of handling sheep on the range. There may be similarities in all sections and in all flocks, but differences and diversity characterize management just as they characterize the range itself. To anyone who is acquainted with the industry, it is difficult to see how it could be otherwise, for management must be adapted to the type of industry carried on, and adaptations must be made in management to best meet the requirements for success which arise from the environmental conditions. Management where the range is fenced will be much different from that where the range is open. Practices followed in areas where winters are severe will be different from those where a relatively mild climate prevails at most seasons. Such generalized statements as "the breeding season is in the fall" and "lambs are born in the spring" do not fit the range-sheep industry. Because of its complexity it is impossible to write fully and at the same time concisely about range-sheep management. There will therefore be many exceptions to the brief treatment given here, but what is given will be an accepted practice in more than one instance.

The purpose of management on the range is basically the same as on a farm; that is, to protect the flock, promote its thrift and health, and to have it produce good quality products economically and abundantly. The fundamental needs with respect to feed, water, salt, and many other items are the same in all sections, for the physiological functions do not change merely because of a difference in location.

Unit of management. Under strictly open-range sheep raising, the unit of management is the number of sheep which can be handled by one man during the greater part of the year. Such a unit is often spoken of as a "band," and the man in charge is a herder. An operator, owner, producer, or manager is not a herder, although the two functions may be combined if only one band is

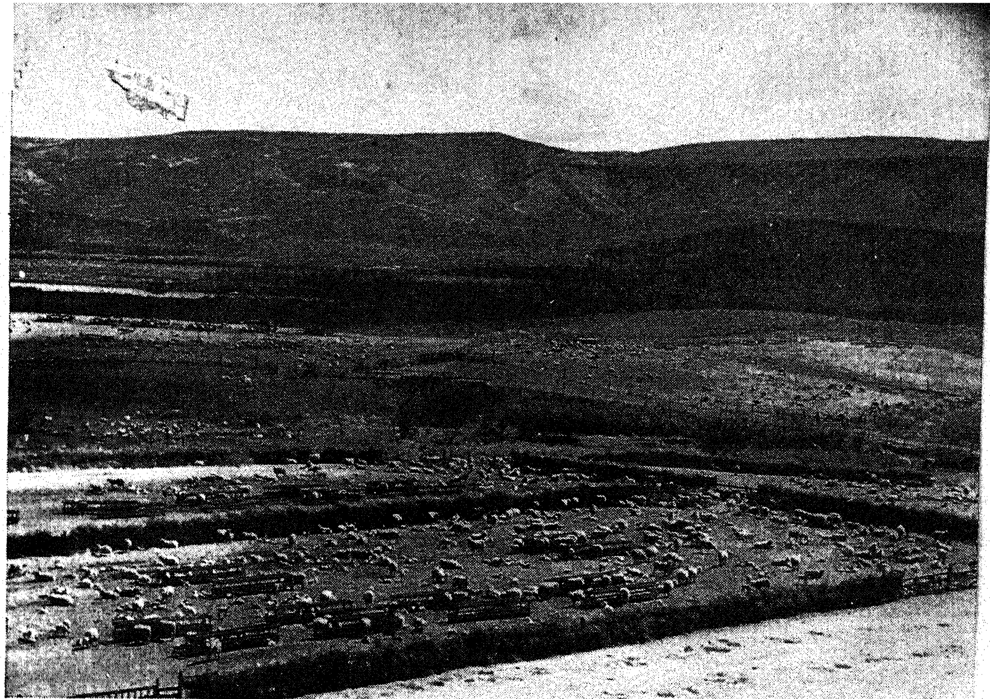


Courtesy Grazing Service

Modern range sheep production requires large investments in animals, land, equipment, and feed.

handled and the operator is so inclined. Such men may own or control one band, or they may have several, depending upon the size of the "outfit" which they have.

Bands are not always the same size. The size may be varied according to the season of the year and, also, according to the method of management and the general character of the country in which the enterprise is conducted. During the winter season a band may contain from about 1,500 to 3,500 ewes. It is seldom that a band exceeds the higher figure, and the average is probably not over 2,000 or 2,500 head. A small operator may not have more than 1,000 mature sheep in his band at any one time. When the lambing season comes, the number of ewes run together is reduced. Then not more than 1,000 head are kept in one group, and often the number may be reduced to half of that figure. After lambing, larger numbers are again "thrown together," and a band on the summer range may include from 1,000 to 1,500 ewes and their lambs in addition. Dry ewes, those which did not lamb or whose lambs have died, are sometimes handled separately from those with lambs.



Courtesy Grazing Service

The number of sheep handled in one group is varied from season to season and also differs in localities.

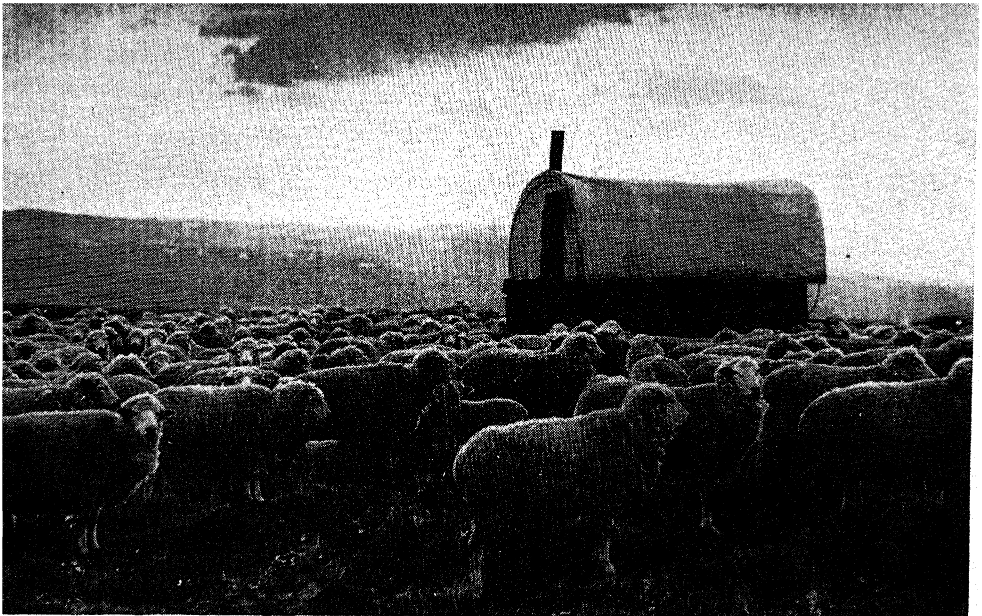
Bucks are handled in separate lots except during the breeding season.

According to a recent study [1] in the southwestern part of the range country, the minimum number of sheep from which an operator could expect to obtain a satisfactory income for a "family-sized" ranch would be 1,700 head. Of this number 78.5 per cent, 1,334 head, would be breeding ewes; 18.7 per cent, 318 head, would be ewe lambs kept for replacements; and 2.8 per cent, 48 head, would be rams. There would, of course, be many items of investment besides the investment in the sheep. The area of land needed under the conditions of the study would be twenty sections, which means that 7.5 acres would be required per sheep. The same minimum-sized unit would hold to some extent for other regions, but there would be some variation because of differences in costs, lambing percentages, weights of lamb and wool per ewe, and in other items.

Montana studies [2] showed that from the standpoint of greatest

---

[1] New Mexico Sta. Bul. 325. 1945.
[2] Mont. Sta. Bul. 302. 1935.



Courtesy Bureau of Animal Industry, U.S.D.A.

It is sunset on an Idaho range. The herder who occupies an unpretentious wagon home cares for a flock worth many thousands of dollars. Despite some instances of unfaithfulness, the great majority of herders follow an ancient calling with loyalty and pride.

efficiency, the optimum-size unit was reached at from 3,600 to 4,500 ewes. This number permitted more specialized use of labor in herding, camp-tending, lambing, shearing, and in general ranch work. It also facilitated the sorting of sheep into bands by ages, by ewe and single or ewe and twin lambs, separation on various bases for breeding, for the best use of forage, and for helping to make fuller use of equipment. A similar conclusion with respect to production in Utah [1] would seem justified, for there it was found that "it is likely that some flocks are too small and others too large for the most profitable combination of operator and circumstances."

The herder and his equipment. Men of all types herd sheep on the open ranges or perform various duties where the sheep are run under fence. In the southern areas many of the herders are Mexicans; in parts of the range country the Basques predominate; in other sections there may be herders of practically any nationality. As in all other occupations there are great differences in the capabilities of the men employed. Herding sheep is generally con-

[1] Utah Agr. Exp. Sta. Bul. 204. 1928.

sidered an extremely lonesome task, as it is not unusual for herders to see very few other people for long periods. But the job has certain fascinations, especially in some sections of the country and during periods of good weather. During severe weather, the conditions are anything but pleasant. Some of the Basques are members of families who have been herders for many generations both here and in such countries as Spain, and they have a high regard for their calling and the special skills which they have acquired.

In most sections of the range, herders live in covered wagons which contain all of the essential equipment for living a great distance from headquarters. The wagons are heavy and strongly built, and within them are such fixtures as stove, cupboards, a few dishes and cooking utensils, a bed, and perhaps a chair or two. The wagons are moved every few days, as the sheep change to new feeding and bedding grounds. Herders must be close to the band at all times in order to protect the flock from predators and to guard against straying. The hours of work are long, for the sheep move out from the bed ground to graze as soon as it begins to become light in the morning. After grazing for some hours, the flock may "shade up" during the heat of mid-day but will resume grazing again about mid-afternoon and will graze until almost dark. Skillful herders know that for the sheep to do well, they must not be disturbed any more than necessary to keep them under control and guide them in the desired direction; otherwise, they will not spread out over the grazing area so that all will have good feed. Very compact grazing is detrimental to all except the few sheep at or near the front of the band. A "good spread" while grazing means greater weights of lambs at marketing time. This is one of the main advantages of running sheep under fence. It is then possible for them to travel over a wide area, and all have some of the best feed. Riding the range to look after fences and inspect the sheep is apt to be less of a disturbance to the flock than herding.

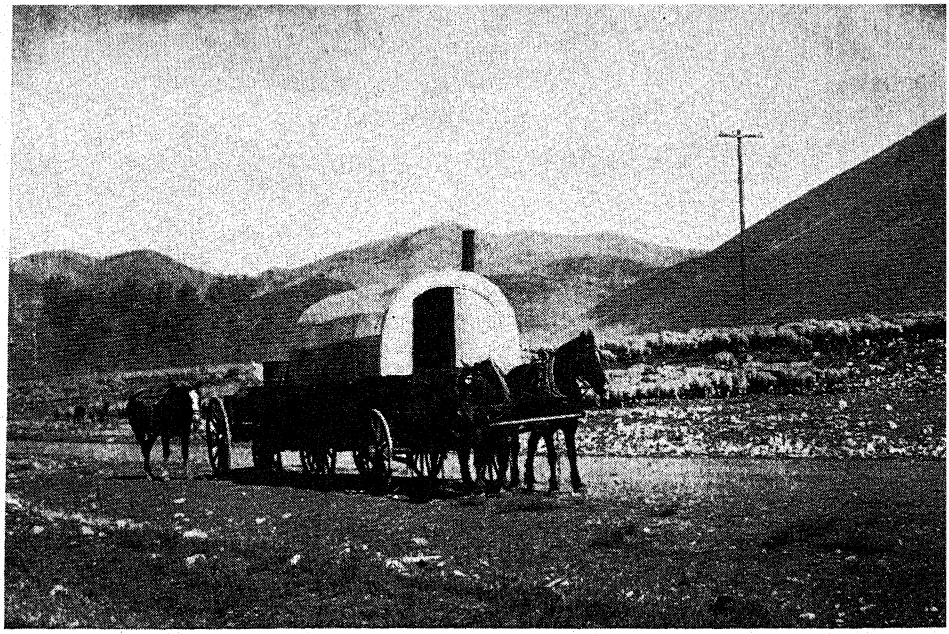
In sections that are too rough for the use of wagons, the herders live in tents, and the supplies are moved on the backs of horses or burros. Most herders occupy wagons on the deserts during the winter season. In any case preparation of his own meals is part of the herder's tasks. The operator or a camp-tender visits him at regular intervals and keeps him in supplies. In some sections the herders are allowed to kill a certain number of sheep for their meat supply, but some variety is usually provided by purchased materials

brought to the wagon or tent by the man in charge of the bands or by the employer.

Herders may do much of their work on horseback in some cases. All of them rely upon dogs. Probably in no other occupation is the dog more essential or more thoroughly trained for his work. The dogs are not all of the same breeding, but they all do have the ability to work as directed by the herders. The dogs must have great stamina and strong legs and feet for strenuous work in rough and stony country. Not only do they help during the day, but they are the guardians of the flock at night. When the herder has selected the bed ground for the night, the flock is worked so that the place is reached about the time the sheep will be ready to lie down. When all have quieted down his work is done, but he must never leave the band alone. Along with his other information he must know the location of water so that the sheep can be driven to it. This may not be a simple matter, for when several different flocks may be dependent upon one source for water care must be taken to prevent them from becoming mixed.

Camp-tending. When several bands are the property of one operator or concern, someone must take supplies to the herders and help them with respect to keeping on the area covered by ownership, leases, or permits. Such men are often known as camp-tenders. They must be thoroughly acquainted with the country in which the sheep are being grazed and be able to direct the herders so they will not encroach on other operators' territory and so the herders and their bands can be readily located at the time of the next visit. The camp-tender brings food, salt, ammunition, other supplies, and an occasional piece of mail. Under some conditions he must also supply grain needed for the horses and see that supplies of feed for supplementing the winter grazing are on hand. The camp-tender's responsibilities are large, for he may have in his care a far greater investment than many of the business men of the cities, and his conditions of operations may require far greater ingenuity.

Factors important in management. Many matters have a relation to the management of sheep on the range. The size of the unit, measured in the number of sheep, has already been mentioned. The size of the land area involved is another important consideration. In the New Mexico study 20 sections of land were needed for a flock of 1,700 sheep. Where more than this number



Courtesy Grazing Service

These sheep are en route to summer range. Hardy, vigorous animals are required for such migrations which may be for distances of a few miles or more than a hundred miles.

is kept, the size in terms of land required may include several hundred sections. Ranch management in such cases, wholly aside from the management of the sheep, becomes a large task. Likewise, in those areas where sheep must be trailed a long distance from one type of range to another for the different seasons, the problems encountered are many and varied. In the Intermountain country[1] as well as elsewhere, many shifts of this kind involve a one-way trailing distance 150 to 250 miles and a few, as much as 350 miles. Any distance of less than about 50 miles is usually considered "adjacent" to the headquarters. Some of the larger operators have bands of sheep grazing in widely separated regions.

The management problems involved during the migration movements are somewhat different from those during the ordinary grazing movements. These long migrations have a serious effect upon production, for they sap the strength of the animals, and there are many deaths. Ewes that are heavy with lamb have difficulty in making long journeys, and if they have already lambed, many of the lambs do not have the requisite strength to survive. There are hazards with respect to the supply of feed and water.

[1] U.S.D.A. Cir. 624. 1942.

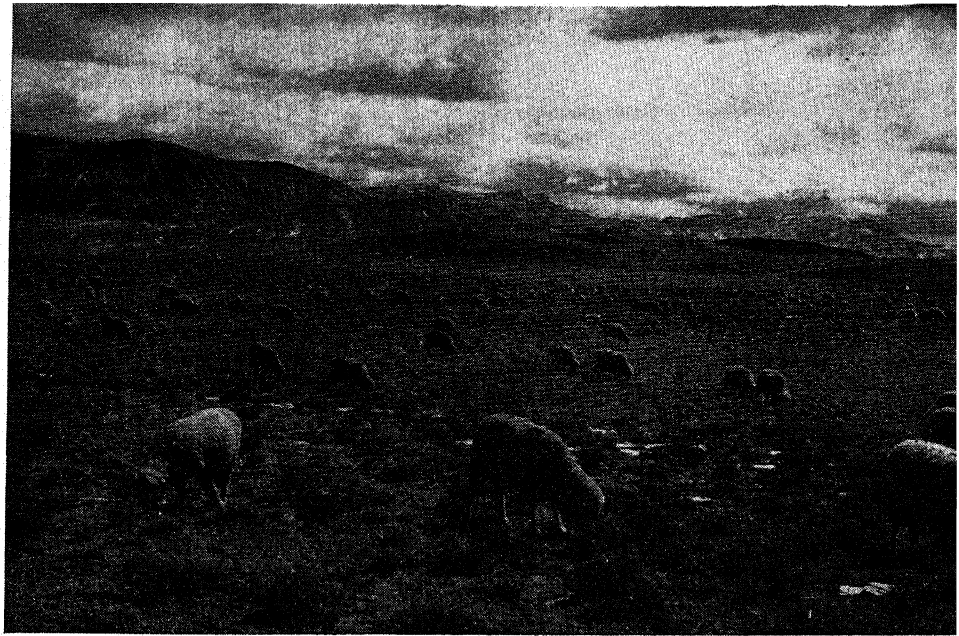
Vehicular traffic introduces more handicaps and hazards. Even where trails or driveways are fenced off to provide for the movement of the flocks, there are difficulties with weakened animals and scarcity of feed. Because of these hazards, some producers ship the sheep to and from winter and summer range.

Certain management practices are associated with the different seasons. Thus, there are matters at the breeding season, lambing time, shearing time, and at marketing that are quite different from the general management during the winter or summer.

The breeding season. Lambs are born in the range country from November until May or June. This means that the breeding season ranges from about July until January. The breeding season is not the same for all sheep in a state or section of the range. In California and in parts of the Southwest the breeding season is during the summer, as many of the lambs are dropped in November and December. In the shed-lambing sections of Oregon, Washington, Idaho, and some other states, the breeding season is from August to September or October. In these states and others where shed-lambing is not practiced, the breeding season may range from about November or December through all or part of January. While the general breeding season may extend over many months, the season in any band is generally limited to a period of about six weeks. This is done so that the lambs will be "bunched," and there will not be too great a difference in age for the general management followed. This is advisable, too, since extra labor must be hired for the lambing season.

The general practice is to use three rams for each hundred ewes. Under certain conditions only two rams may be used for that many ewes. Some operators follow the practice of flushing the ewes and conditioning the rams by placing them on better feed for a short time before the season begins. Some consider it advisable to place part of the rams with the ewes during the night and to remove them during the day, when they are fed and rested. Another lot of rams similarly handled is put with the ewes during the day. Other managers use a longer period for rest, and others put only part of the rams in during the first two weeks and add the others after that period. All of these things and others are done for the purpose of getting the maximum number of ewes bred during a short period.

Range use is very hard on rams, and it is for this reason that rangemen insist on rams of good size, strong constitution, and



Courtesy U. S. Forest Service

For sheep grazing on winter range in western Utah the forage is chiefly winter fat, rabbit brush, and black sage.

sturdy legs and good feet. Rams lacking in these essentials cannot follow a grazing flock over a large area. Rams lose considerable weight during this season. Rams of certain breeds are considered practically worthless for use on the range, as they have been bred with too little emphasis on size and on certain utility features, such as ability to see and to travel.

Those who are engaged in the production of market lambs usually buy rams from men who specialize in their production. Many of the rams used are purebreds, but there are also many of crossbred ancestry in use. In general, the most progressive operators use purebred rams, but there is little room for sentimentality in the business, and if rams of one breed fail to meet expectations there is no hesitancy in changing. Most rams are used in the same flock for as long as they are useful. This may be only one or two seasons, or it may be for four or five years.

Winter management. Winter management varies considerably. Part of this variation is associated with the climatic conditions in the various regions, and part is due to modifications necessary because of the different times at which the bands of ewes will lamb. Where there is good range for early-lambing ewes, there may be little supplementary feeding. Where the ewes are bred to lamb

Courtesy Bureau Agricultural Economics, U.S.D.A.

These sheep are on winter range in southern Nevada where the snow has covered all forage except the tallest browse plants. Supplementary feeding is necessary following such storm periods.

late or after grass growth has started, there may be little supplementary feeding except during periods of bad weather or when the range feed is scarce due to drought or other cause. When supplementary feeding is done, the feed may be hay—especially alfalfa, or some protein concentrate, cottonseed cake, linseed cake, or soybean cake. For use on the range where the feed may be scattered on the ground, cake or pellets are much better than meals, for there is less loss from wind, and the feed can be more easily gathered by the sheep.

To feed sheep is three or four times as costly per day as to have them get their feed by grazing. To neglect to feed when necessary is likely to lead to considerably increased death losses and reduced production of lambs and wool. Hence, the judgment of the operator becomes a significant matter in this respect. The length of the feeding season may not exceed a month in some sections. In some sections the feeding season in some years may be only a few weeks; in other years it may extend for four or five months. Weather conditions are of great importance in winter management.

For shed-lambing, ewes are generally fed for some time before the lambs are born and also until range feed is available in good amounts afterwards. In some of the best-managed flocks, both grain and hay are fed at both periods. After lambing, more grain is fed in

order to help the ewes maintain a good level of milk production for their lambs.

Most of the flocks are not sheltered during the winter except those that are kept for shed-lambing. Even with these, the time when they are sheltered by buildings may be very short. At other times they depend upon windbreaks of various kinds or seek shelter among the shrub growth.

Lambing time. Most of the practices followed at lambing time are derived from adjustments that have been made on the basis of the operator's experience. Care at lambing time is needed if large percentages of the lambs dropped are to be saved. That is the reason why extra labor is employed at this season. Attention both night and day is necessary, and a band that has been under the care of one man nearly to lambing time may then be cared for by several men. These men have the tasks of assisting ewes that have difficulty in delivering their lambs, helping the lambs to nurse, making "grafts" of disowned lambs, placing the ewe and her offspring in lambing pens, and providing feed and water. The tasks vary with the type of lambing followed.

Shed-lambing involves more tasks than lambing on the range. In the latter case many of the ewes and their lambs are not given any special attention unless there is some difficulty. The herders may try to hold a group of ewes that have newborn lambs together until the lambs are old enough to travel in a larger group. Sometimes in lambing on the open range, the ewes and lambs may be placed in corrals for a few days. In some corrals there may be individual pens in which some or all of the pairs are placed until they are thoroughly accustomed to each other, and the lamb is strong enough to be put in with a larger group. Many ewes lamb without these practices being followed, but increasing costs and the necessity of saving as many of the lambs as possible are forcing more operators to give extra attention.

The drop band may be placed in a corral at night, and lambs born during that time are kept with their mothers in a separate corral, while the ewes that have not lambed are moved off to graze. On some ranches use is made of a drop wagon, and the ewes and their lambs are placed in this. When a load has been gathered, they are taken to the corral or to pens. The drop wagon is partitioned off into compartments for a ewe and lamb. Sometimes a pole sled is used for this purpose. Regardless of the device used, the purpose

Courtesy Grazing Service

Lambs are born at different seasons in various parts of the range country. Early or shed lambing during the winter and early spring is common in parts of Idaho and other northwestern states. Special equipment, such as lamb creeps and windbreaks, is used at this time.

is the same; that is, to get the ewe and lamb together where they may be given attention.

Lambing sheds are of various types. Some are permanent structures, while others are made of poles with canvas covers. In some there is provision for a heating stove, but in others the only heat may be from the sheep and a few lanterns hung about mainly for light. In some areas the sheds will be open on the south, while in others all sides are enclosed. Some lambing sheds have nothing more than a narrow central alley with "jugs" or "cells" on both sides. Other sheds have a large space in the center which may be as much as 24 or 32 feet wide. Gates or hurdles are used to divide this space into rather large pens. At the sides are lambing pens for individual ewes. There are also some larger pens for lots of ten or twenty head. Where careful attention is given, each ewe and her

Courtesy U. S. Forest Service

These sheep are on spring-fall range where they find many palatable shrubs, weeds, and grasses. Such range is an important part of the year-around feed supply.

lamb or lambs are branded with the same mark or number on the same part of the body. This serves as a quick means of identifying each pair. If all is going well, the ewes and lambs of one day's or one night's drop, if there are not too many, are kept in a larger pen together for about two or three days; they are then turned out with others as the ewe and lamb bands are made up. Some operators keep ewes with twin lambs separate from those with single lambs. Some operators use lambing teepees, which are set up over a ewe and her lamb if the weather is stormy and cold. If the ewe does not own her lamb, special effort is made to make her do so. In some flocks the tags are clipped from about the udder before lambing, while in others this work is done when the ewe is placed in the "jug." In others it is not done.

Docking and castrating, when the lambs are about two weeks

old, conclude most of the special management tasks associated with the lambing period.

Shearing time. Shearing and handling of wool have been discussed in earlier chapters, but there are a few items which pertain especially to management at that time. Shearing is an annual event in most flocks, but there are areas in the southern range states where many producers have their flocks shorn twice during a year's time. Shearing time is almost entirely dictated by the climate. In the regions where cold storms occur, shearing must be delayed until there is little danger of storms; otherwise, there would be severe losses. As an extra precaution many sheep are shorn with thick combs so that a small amount of wool will be left for protection. Others are shorn with hand shears for the same reason. In sections where sheep use different areas for summer than for winter grazing, the shearing may be done as the sheep leave the winter sections and are grazing near the operator's lambing grounds.

There is always a question whether to shear before the ewes drop their lambs or afterwards. The main advantages to shearing at the earlier time are: (1) less wool is lost on the brush; (2) the wool may be of lighter shrinkage and there will be less taggy locks; (3) shearing may be done nearer shipping points where feed conditions would not be satisfactory for ewes and lambs; and (4) there is nothing to interfere with the lambs' nursing. Disadvantages are: (1) there is more danger of loss from exposure due to the earlier shearing; (2) there may be some loss of lambs due to rough handling of the ewes; and (3) fleece weights may be less.

Shearing may be done at shearing plants, which consist of several corrals and perhaps a "sweat shed" and shelter containing some equipment for handling the sheep and the wool, or it may be done at some point where a portable plant is set up for the purpose. Better feed conditions may be the main advantage of the latter. Most shearing is done by professionals at a per head rate. The rate varies to some extent with the type of sheep and with the details of the arrangement. Costs have advanced greatly in recent years. Some years ago shearing charges were from 7 to 10 cents per head; now they are three to four times those amounts. After shearing, tying, and sacking, the wool is hauled to a shipping point. If the flock is to be dipped, this is usually done about two weeks after shearing. The return from wool will usually vary from about 40 to more than 50 per cent of the total return from the flock, depending upon the type

Courtesy U. S. Forest Service

These sheep are on summer range. Open areas within the forests at high elevations where feed is abundant and water close by provide ideal conditions for sheep. Careful range and flock management are vital factors in continuous successful production.

of sheep, lamb crop, fleece weights, and feed conditions. The balance of the return comes chiefly from the sale of lambs.

Summer management. Under fenced range the bands graze more or less undisturbed except as some members of the flock may need attention because of being fly struck or for some other reason. Feed, water, and salt are the three requisites aside from incidental attention. To the experienced sheepman, the actions of a sheep indicate at once whether attention is needed. In sections where internal parasites are a problem, preventive measures must be followed.

On the open range the herder watches the band in accordance with instructions from the camp-tender or operator. If the forage supply is good and conditions generally favorable, there will be a large percentage of fat lambs at the end of the summer grazing period. If under such conditions there are few fat lambs, either the sheep are not of the right type or the herder has done a poor job of

looking after the band. On the drier plains areas it is not possible for the lambs to grow and fatten as they do under the more favorable conditions of the mountains. On the plains it is not a question of herding but one of feed in trying to obtain fat lambs.

Marketing. Many operators "cut off" the lambs from their mothers while they are still on the summer ranges and have the lambs hauled by trucks to a rail shipping point, or they are taken direct to a market by truck. Other operators have the ewes and lambs trailed from the mountains to a shipping point or to the ranch headquarters, where the lambs are sorted off for shipment. Ewes may be culled at this time too, or that task may be left until the breeding bands are made up later in the year.

The lambs may be sold by shipping to markets, on the range at shipping time, or they may be sold by contract some time earlier in the season. When selling on the range, the whole lot of lambs may be sold "straight across" at a certain price per hundred pounds, or they may be sold on the basis of a set price for the "fat end" and at another price for the "feeder end." Details are arranged by buyer and seller, although there are some more or less standard trading practices. Among these is the custom of withholding feed and water for a twelve-hour period before weighing, or, if this is not done, a three or four per cent shrink on the total weight is allowed.

Costs of operation. The matter of cost is one of extreme variability. During the war years costs have increased to such a degree that cost studies prior to that time are of little consequence except from an historical standpoint, or they may be used to show how the percentage costs have varied. Costs also differ widely in various parts of the range country, and the costs of operators in one section are of little value to those in another. Records of costs of a particular concern are most valuable for study by that concern. Comparisons with other costs may be indicative of possibilities or the need of improved management practices or of greater economy of operation with respect to some phases of the business. Items of cost that are of major importance are labor, feed, grazing fees, capital investment, use of equipment, death losses, taxes, interest, and depreciation. Lambing percentage, per cent of lambs raised, yield and quality of wool, as well as prices for lambs and wool are matters which have a bearing on the returns. Cost items must always be considered in relation to the returns. It has been shown [1] that under

[1] Wyo. Agr. Exp. Sta. Bul. 156.

certain conditions "an operator can afford to spend 65 cents more per head each year on his ewes, if by so doing he can increase his lamb crop 10 per cent."

Operating costs per head in Montana[1] are estimated as ranging from 80 cents in 1896 to $5.50 in 1928 and $3.25 in 1932. These costs are exclusive of interest. For the same years the net income was represented by a loss of three cents per head in 1897 and 60 cents in 1932, while in 1928 the profit was $1.17 per head. For the period 1890 to 1932 inclusive there were six years when there was a net loss of from 3 cents to $1.10 per head. For the other years there was a profit ranging from 16 cents to $4.52 per head. The latter figure was for the year 1917. It is likely true that present costs are higher than at any time covered by this study. It is interesting to note that the total investment per head during this time (1890–1932) varied from a low of $2.65 to a high of $34.00.

Other cost data are given in Utah Bulletin 204. These data gathered in 1925 cover 137,000 sheep, which would be about 5 per cent of all the sheep in the state at the time. The data are grouped according to the size of ranch, but only the averages for the fifty-four ranches studied are given in the table.

TABLE 55

AVERAGE COST PER BREEDING EWE IN UTAH FOR 1925

Cost item	Amount	Approximate per cent of total cost
Hay and grain	$0.84	17
Pasture and range	.22	
Labor	2.31	36
Shearing	.30	5
Taxes	.31	5
Interest paid	.42	6
Death loss and missing	1.28	20
Depreciation [a]	.23	4
Miscellaneous	.47	8
Total cost	$6.48	100

[a] On buildings and machinery

Costs for the same year for thirty-seven outfits in Idaho and covering 147,850 ewes were given as shown in Table 56 on page 522.

[1] Mont. Agr. Exp. Sta. Bul. 302. 1935.

TABLE 56

COST PER EWE IN IDAHO FOR 1925

Cost item	Amount	Approximate per cent of total cost
Hay and grain	$2.93	28
Labor	2.24	21
Supplies	.62	6
Pasture and range	.50	5
Shearing	.23	2
Taxes	.23	2
Other expense	.79	8
Interest paid	.93	9
Loss	.99	10
Depreciation	.91	9
Total cost	$10.37	100

In Nevada [1] the gross carrying cost per head per year for a six-year period, 1933 to 1938, was $3.04. This included a labor cost of $1.33, which was 43.8 per cent of the total cost. Supplies amounted to $0.70 or 23 per cent, and all other costs, $1.01 or 33.2 per cent. In this report other costs included costs of feeds and grazing, taxes, insurance, management, and depreciation. Feeds and grazing charges amounted to $0.60, which was 19.7 per cent of the total. There was great variation in the costs for the different years of the study. Much of the difference was due to the fact that weather plays such an important part in the production of range livestock. Supplementary feed purchases varied greatly.

Lambing percentage. As an item affecting returns, lambing percentage is one of importance. Based on the number of ewes at lambing and the number of lambs docked, the six-year-average lambing percentage for Nevada operators for the years 1933 to 1938 was 76.05. The lowest for the six years was 66.59 per cent, and the highest, 81.96 per cent.

For five years in New Mexico the average lambing percentage based on the number docked was 77.7. The range was from 67.5 to 80.9 per cent. Under more favorable conditions that exist in some sections and on some ranches, the percentage may be higher than the figures given. It is likely that for the entire range country the lambing percentage is between 75 and 80 per cent. While these figures may seem low, it should be understood that they do not rep-

[1] Nevada Agr. Exp. Sta. Bul. 151.

resent the percentage of lambs raised. In Utah the percentage of lambs lost between marking time and marketing was 12.1 per cent; in Nevada the loss amounted to an average of 12.5 per cent. In New Mexico it was reported that as an average for five years, 73.8 per cent of the lamb crop docked was raised. Some of these losses were due to lack of feed, the effects of docking and castrating, predators, disease, and so on.

Another way to consider lamb production is on the basis of the pounds of lamb per ewe. This too varies greatly. Probably one of the highest records was that of 100 pounds of lamb per ewe reported for a flock in Washington.[1] The New Mexico report, covering five years, shows a production of 48.3 pounds of lamb per ewe as an average for the period. In Nevada the net lamb production based on the number of ewes bred was 61.51 pounds as an average for six years.

Death loss. The above are matters that have a direct bearing upon the returns from the enterprise. But it is not only with lambs that death losses are encountered. There are many losses of mature sheep, arising from a variety of causes. Death losses of mature sheep range from about 6 to 15 per cent, and the average is probably in the neighborhood of 10 per cent. Chief among the causes of loss may be listed those due to difficulties at lambing time, storms soon after shearing, and exposure because of lack of shelter, poisonous plants, predatory animals, disease, parasites, lack of feed, and straying.

Efficiency factors. Efficiency and careful management are among the most important factors that influence profits. Some matters are not wholly under the control of the operator, but others are subject to improvement or deterioration in accordance to the knowledge possessed by the operator and the wisdom and judgment with which he directs the operation of the outfit. The direction is facilitated when it is possible to employ intelligent and skilled labor for many of the tasks. The operator has under his control, too, the general type and quality of the sheep which he buys or raises, through the selection of the ewes and rams and through the kind of care they are given.

Weather conditions have a great effect upon sheep and upon the feed which is available for them. Weather is much more important at some seasons than at others. Feed conditions, while

[1] National Wool Grower. Vol. 28. No. 4. 1938.

largely a matter of weather, are improved or reduced through the way the sheep are managed and through range and pasture management. The best of weather conditions cannot possibly overcome the effects of bad management. Neither can good management wholly overcome the effects of drought and other climatic conditions which have such profound effects upon vegetation. The avoidance of overgrazing and the provision of supplementary feeds during winter are matters that seem to offer the most opportunity for improvement in the chances for success, for through these, death losses may be reduced and the growth of lambs and wool promoted.

Likewise, there are certain things which may be done to insure larger lamb crops and saving more of the lambs born. Much of the work in handling a band cannot be done with so much care as should be used, but there is considerable handling of both mature sheep and lambs which is much rougher than is necessary. Few appreciate the value of care and cleanliness at lambing time or when docking and castrating are being done. Many lambs are born in quarters that could be kept much cleaner if the operators and attendants realized how important such matters might be. Some of the troubles with newborn lambs are due directly to a lack of sanitation and cleanliness. The disinfection of navels of lambs born in sheds is not universally practiced. Dysentery, that is common in some flocks, is a trouble that is directly associated with filth. Many other matters are also so related. Progress in knowledge cannot be of most usefulness unless that information is sought by the operators and applied.

Condition of the range bears directly upon the weights of lambs and fleeces. Top lambs and heavy fleeces cannot be obtained from poor ranges. But good ranges will not produce a dense, long-stapled fleece on a sheep that naturally has a fleece lacking in those features. Neither will good range make a top lamb from a fine-boned, wrinkly-hided, wool-blind lamb that is nursing a mother that produces little or no milk. Culling and selection of breeding stock is under the control of the operator. Investigational work has shown upon what bases these things should be done. To ignore these findings is to try to think facts out of existence.

A large percentage of the total investment in sheep rather than in land is a factor in securing good returns. Increased land values have made it difficult to maintain such a relationship. Present-day expansion may be made more effectively at times through improve-

ment in quality and methods than through increased numbers of animals and additional acres. Bigness is not always an accompaniment of efficiency. In fact, reports given in Utah Bulletin 204 show that ranches running from 2,000 to 3,000 breeding ewes made a larger percentage return than those having either smaller or larger numbers. It is shown in Wyoming Station Bulletin 156 that the largest returns were obtained by ranches in the Red Desert area that had between 4,000 and 9,000 breeding ewes. There are very likely large differences in the most efficient size of outfit, depending upon the section of the country and the efficiency of the operator, but the size should be such that the investment in sheep represents about 50 to 70 per cent of the total investment.

APPENDIX

Average Amounts of Digestible Nutrients and Calcium and Phosphorus in 100 Pounds of Common Feeds [1]

	Digestible Protein	Total Digestible	Calcium	Phosphorus
Concentrates	*Pounds*	*Pounds*	*Grams*	*Grams*
Barley	9.7	77.1	21.8	144.2
Coconut oil meal	18.5	82.5	—	—
Corn, dent	7.3	81.5	4.5	107.8
Corn and cob meal	6.1	78.1	—	—
Corn gluten feed	22.5	78.0	72.1	368.3
Corn gluten meal	37.7	80.5	39.0	189.2
Cottonseed meal (43% protein)	37.6	80.2	—	—
Cottonseed meal (40% protein)	33.5	73.6	86.5	511.2
Cottonseed meal (below 36% protein)	26.1	65.6	—	—
Dried beet pulp	5.3	73.7	328.0	42.2
Dried beet pulp with molasses	6.9	72.7	247.3	27.7
Dried brewers' grains	24.0	66.8	128.4	235.4
Feterita	9.9	79.2	—	—
Flaxseed	20.6	102 8	115.2	297.1
Kafir	9.2	80.0	—	—
Linseed oil meal (35.5% protein)	32.5	75.3	160.0	248.8
Molasses (beet)	2.9	58.7	23.0	9.5
Molasses (cane)	1.3	55.9	400.9	28.9
Oats	10.2	69.5	40.8	134.5
Peanut oil meal (45% protein)	41.0	82.5	—	—
Rye	9.1	81.9	23.4	194.6
Soybeans (ground)	33.7	92.3	91.0	271.0
Soybean oil meal	37.8	82.3	107.0	282.6
Wheat	8.8	79.2	16.6	159.8
Wheat bran	12.9	67.6	42.8	571.0
Wheat middlings	15.2	78.4	39.9	365.6
Dried Roughages				
Alfalfa hay (prebloom)	14.8	53.4	720.0	85.0
Alfalfa hay early cut	11.6	51.4	715.3	86.7
Alfalfa hay medium cut	10.4	51.5	586.9	92.1
Alfalfa hay late cut	9.6	48.7	428.2	102.1
Clover, alsike	7.9	47.3	360.0	97.0
Clover, red	7.4	49.6	541.6	81.6
Cowpea hay	13.1	49.8	—	—
Corn fodder	3.7	48.1	97.0	65.0
Corn stover	2.0	36.4	65.4	40.0
Kafir fodder	3.5	46.1	—	—
Lespedeza hay	10.0	51.3	—	—
Millet hay	4.5	49.0	—	—
Mixed hay (½ clover, ½ timothy)	5.1	49.3	366.1	76.5
Oat hay	4.7	45.5	—	—
Oat straw	1.0	45.6	161.9	64.9
Pea hay	10.3	52.2	—	—
Prairie hay	2.8	48.3	213.5	33.9
Red top hay	4.8	54.1	—	—
Reed canary grass hay	4.5	52.3	—	—
Soybean hay	7.9	50.0	430.9	115.6
Sudan grass hay	3.7	51.4	—	—
Sweet clover hay	10.9	50.7	548.9	93.0
Timothy hay	2.9	48.0	136.7	65.4
Vetch hay	9.1	52.4	—	—
Wheat straw	0.7	36.9	106.6	40.4
Succulent Feeds and Miscellaneous				
Alfalfa silage (average water)	4.0	16.0	—	—
Corn silage	1.2	16.8	31.0	30.0
Sunflower silage	1.0	13.7	163.7	19.3
Corn cannery silage	1.1	17.8	—	—
Pea cannery silage	2.8	15.3	—	—
Potatoes	1.1	17.3	—	—
Beets	1.3	11.5	—	—
Mangels	1.0	6.5	32.5	17.8
Rutabagas	1.0	9.5	39.0	21.8
Bonemeal (Minerals only)	—	—	13,105.0	5,967.0
Limestone (Minerals only)	—	—	18,144.0	—

[1] Data taken from Minn. Agr. Expt. Sta. Bul. 218 and various Experiment Station publications. For feeds not listed in this table see Morrison, *Feeds and Feeding*.

Index

Abortion, 466
Adapting sheep to farm, 159
Age, 31
  and production, 170, 172
Ailments of lambs, 307
Alfalfa
  hay, 275
  pasture, 269
Anthrax, 454
Artificial insemination, 206

Barley
  grain, 285
  pasture, 271
Bedding, 304
  down, 35
Beets, 282
"Bighead," 462
Black-faced Highland, 136
Blackleg, 455
Bloat, 461
Blowflies, 487
Break joint, 23, 34
Breeding
  and economic features, 223
  and shows, 224
  ewe lambs, 171
  habits, 26
  practices, 231
  principles of, 201
  season, 27, 231
  season on ranges, 512
  sheep
    depreciation in value, 163
  systems, 225
Breeds
  adaptation of, 39
  and grades of wool, 423
  classification, 40
Breeds—(*Continued*)
  descriptions, 44
  development, 45
  histories, 44
  list of
    Black-faced Highland, 136
    Cheviot, 86
    Columbia, 95
    Corriedale, 90
    Cotswold, 107
    Dorset, 81
    Hampshire, 62
    Karakul, 139
    Lincoln, 103
    Oxford, 76
    Panama, 134
    New breeds, 134
    Rambouillet, 124
    Romeldale, 134
    Romney, 110
    Ryeland, 137
    Shropshire, 54
    Southdale, 134
    Southdown, 47
    Suffolk, 71
    Tailless, 134
    Targhee, 138
Buildings, 189
Buying
  ewes, 166
  feeder lambs, 357

Calcium, 250
  content of feeds, 526
Calculi, 463
Carbohydrates, 244
Carding wool, 449
Castration, 318
Catarrh, nasal, 465

Characteristics of feeder lambs, 352
Cheviot, 86
Chilled lambs, 307
Classes of sheep, 146
Clover
  hay, 275
  pasture, 270
Cobalt, 252
Coccidiosis, 458
Colostrum, 310
Columbia, 95
Combing wool, 450
Concentrates, 283
Condition, 152
Constipation in lambs, 307
Contract lamb feeding, 358
Copper, 252
Corn, 283
Corriedale, 90
Costs in lamb feeding, 342
Costs of range operation, 520
Cotswold, 107
Cowpeas, 273
  hay, 276
Creep feeding, 313
Crossbreeding, 229
Cutting chute, 196

Deaths in lamb feeding, 345
Depreciation in value, 163
Diarrhea, 457
Digestible nutrients, 246
  content of feeds, 526
Digestion, 255
Dipping
  sheep, 472
  vat, 197
Diseases, 38, 452
  classification, 454
Docking, 318
Dogs, 37
Dorset, 81
Drenching sheep, 478
Drinking water, 35
Dysentery, 307

Equipment
  cutting chute, 196
Equipment—(*Continued*)
  dipping vat, 197
  feed racks, 192
  feed yards, 191
  fences, 190
  hurdle, 200
  trimming stand, 199
Establishing a flock, 163
Estrus, 232
  control of, 232
  occurrence of, 233
Eversion, 466
Ewe lambs
  breeding, 171
  selection of, 240
Ewes
  age, 170
  characteristics desired, 169
  condition, 178
  form, 177
  health, 169
  kinds, 167
  number per ram, 234
  size, 173
  soundness, 170
  temperament, 178
  uniformity, 179
  wool, 178
External characters, 15

Factors
  of efficiency, 186
  of efficient range, 523
Farm flocks, 10
Fat in ration, 244
Feces, 257
Feed
  classes of, 258
  costs, 343
  how sheep feed, 34
  preparation, 288
  racks, 192
  yards, 191
Feeder lambs
  grades of, 354
  selection, 347
Feeding
  breeding sheep, 291
  growing lambs, 309
  period, length of, 365
  pregnant ewes, 295

Femininity, 43
Fences, 190
  for sheep, 36
Fetus, 210
Financing sheep raising, 14
Flock
  establishment, 163
  requirements, 165
  size
    of farm, 163
    of range, 505
Flocking tendencies, 35
Flourine, 253
Flukes, liver, 486
Flushing, 292
Fodder, 279
Founder, 460

Genetics and breeding, 220
Genetic terms, 213
Gestation period, 294
Grades
  and crossbreds, 46
  of feeder lambs, 354
Grain
  for bred ewes, 301
  troughs, 193
Grass
  hay, 274
  pastures, 267
Grazing management, 289
"Grub in the head," 489

Hampshire, 62
Hand- versus self-feeding, 371
Hays, 274
Hemorrhagic septicemia, 464
Hurdle, extension type, 200

Inbreeding, 226
Inheritance, 217
Intestinal tract, 24
Iodine, 251
Iron, 252

Judging sheep, 145

Karakul, 139
Ketosis, 465

Lamb consumption, 6
Lamb feeding, 11
  areas, 326
  contracts, 358
  costs, 342
  history, 324
  influence of sex, 366
  management, 360
  margin, 336
  rations, 373
  risks of, 333
  schedule, 363
  seasonal, 334
  supplements, 385
  systems, 328
    field, 328, 382
    open yard, 330
    shed, 329
Lambing
  pens, 304
  percentage on ranges, 522
  shed, range, 515
Lambs
  birth weight and feed, 297
  black-faced, 148
  ewes versus wethers, 366
  fed, 148
  growth, 28
  hothouse, 147
  native, 148, 354
  numbers at birth, 26
  orphan, 312
  slaughter, 160
  spring, 148
  troubles, 307
  versus sheep, 331
  weight at birth, 27
Legume
  hay, 275
  pasture, 269

Leicester, 99
Lespedeza
  hay, 276
  pasture, 270
Lice, 471
Lincoln, 103
Linebreeding, 227
Listrellosis, 462
Lungworms, 485

Magnesium, 252
Management
  after weaning, 31t
  at lambing, 304
  bred ewes, 295
  ewes after lambing, 308
  feeder lambs, 360
Manure, 257
Margin
  and costs, 341
  in lamb feeding, 336
Market
  classes of sheep, 147
  grade, 149
    determination of, 150
      for breeding, 154
      for feeding, 152
      for slaughter, 150
Marketing
  lambs, 520
  wool, 442
Masculinity, 42
Mass selection, 225
Mastitis, 467
Merino, 115
Milk, yield, 240
  and composition, 310
Minerals, 249
  in soil, 260
  poisoning, 253
  supplements, 252

Nasal flies, 489
Native lambs as feeders, 355
Navel ill, 457
New breeds, 134
Nodular worms, 481
Nonlegume hays, 277
Nutrients
  daily amounts, 248
  for sheep, 243
Nutrition and soil, 259
Nutritional balance, 255
Nutritive value of plants, 262

Oats, 283
  and peas, 272
Orphan lambs, 312
Ovaries, 208
Overeating, 459
Oxford, 76

Palatability of plants, 264
Panama, 134
Parasites
  external, 468
  internal, 472
Pasture, 265
  for lambs, 315
  management, 289
Phosphorus, 250
  content of feeds, 526
Plant
  composition, 262
  poisoning, 490
Pneumonia, 463
Potassium, 252
Predatory animals, 37, 491
Pregnancy disease, 465
Profit
  factors relating to, 160, 523
Progeny test, 226
Prolificacy, 235
Protection of sheep, 36
Protein, 245
  concentrates, 286
Purebreds
  selection of, 179
  versus grades, 168

Quality
in sheep, 151
in wool, 417
Rambouillet, 124
Rams
characteristics desired, 179
feeding, 292, 316
influence on lambs, 184
Range
flocks, 7
history, 494
industry, 492
ownership, 500
sheep management, 505
breeding season, 512
camp tending, 510
costs of operation, 520
death losses, 523
herders, 508
important factors in, 511, 523
in summer, 519
in winter, 513
lambing time, 515
lamb marketing, 147, 520
shearing, 518
vegetation, 497
versus native lambs, 354
Rape, 272
Rations
for feeding lambs, 373
grains, 376
pastures, 374
proportion of grain and roughage, 377
silage, 381
Records, importance of, 241
Reproduction, 202
Returns
in lamb feeding, 338
effect of
buying price, 338
feed required, 339
weight, 340
Romeldale, 134
Romney, 110
Root crops, 281
dry matter of, 282
Roundworms, 474, 480
Rye
grain, 285
pasture, 271
Ryeland, 137
Salt, 249
Sanitation, 453
Scab, 468
Scouring wool, 448
Screenings, 287
Selection of
ewe lambs, 240
ewes, 169
feeder lambs, 347
ram lambs, 179
Self-feeders, 194
Self-feeding lambs, 314, 364
Sex characteristics, 42
Sexual maturity, 203
Shade, 291
Shearing, 431
feeder lambs, 366
on range, 518
Sheep
and cattle, 17
industry, 3
effect of war on, 4
sources of income, 5
use of land, 6
raising
handicaps, 162
opportunities, 161
organization for, 158
shorn in United States, 166
Shelter
for farm flock, 295
for feeding lambs, 369
space required, 189
Shows and breeding, 224
Shrink in shipping, 341
Shropshire, 54
Silage, 279
crops, 280
for ewes, 300
for lambs, 381
Size of ewes and production, 175
Skeleton, 20
Skin, 19
Sore eyes, 307

Sore mouth, 307, 456
Sore teats, 308
Sorghums, 285
Southdale, 134
Southdown, 47
Soybean
  hay, 276
  pasture, 273
Sperm cells, 205
Stiff lambs, 455
Stomach worms, 474
Straw as feed, 278
Sudan grass, 272
Suffolk, 71
Sulphur, 252
Supplements in lamb feeding, 385

Tailless sheep, 134
Tapeworms, 483
Targhee, 138
Tariffs, on wool, 392
Temperature, body, 25
Teeth, 23
  indication of age, 31, 149
Testicles, 203
Tetanus, 455
Ticks, 470
Trimming stand, 199
Tunis, 135
Twinning, 236
Twins, growth of, 238
Tying wool, 440
Types
  of feeder lambs, 347
  of sheep raising, 7

Vitamins, 253

Water
  amount, 35, 296
Water—(*Continued*)
  troughs, 194
  uses in body, 243
Weight in
  breeding ewes, 157
  feeder lambs, 156, 351
  market lambs, 156
Wethers, 44
Wheat
  grain, 285
  pasture, 271
Whipworms, 482
Wool
  balls, 308
  carding, 449
  characteristics of, 417
  chemical composition, 413
  classes of, 419
  consumption, 5, 161, 390
  exporting countries, 389
  fabric labeling, 396
  fiber, features of, 407, 411
  general properties, 419
  grades, 420
    from breeds, 423
    proportions of, 445
    standards for, 423
  growth of, 407
  manufacture, 448
  marketing, 431
    agencies, 442
    costs, 446
  packing for sale, 441
  postwar aspects, 394
  production, 161
  sack holder, 200
  scouring, 448
  shrinkage, 418
  storage, 442, 446
  tariffs, 392
  terms, 398
  top, 450
  tying, 440
  uses of, 388
  value, 388, 417
  variations in, 16
  world industry, 390

Yolk, 410